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SOCIAL IMPLICATIONS OF AUTOMATIC CONTROL IN INDUSTRY

THE broadsheet "Towards the Automatic Factory", issued by Political and Economic Planning (No. 380; June 13, 1955), appeared almost simultaneously with a conference at Margate, June 17–19, arranged by the Institution of Production Engineers, which has given wide currency in Britain to the term 'automation', coined by the Americans to cover developments towards automatic operation and control. This conference, which was the first expert gathering in Britain to approach the subject comprehensively and systematically, was attended by more than a thousand engineers, scientists and factory managers, and both the broadsheet and the conference have done something to clarify ideas as to the distinction between mechanization and 'automation', and also to indicate both the practical possibilities and the limitations of the automatic factory, and the human, as well as the technical, problems that are involved. They indicate the possibilities which the rapid technological developments of the post-war years have opened up and something of the implications not merely for industry, but also for science, for education and for society in general.

'Automation' was defined by R. K. Geiser at a conference on automation and industrial development at Syracuse, New York, in May 1954, as "the accomplishment of a job by an integrated mechanism with a minimum of assistance of any kind". Full automation, in this sense, does not yet exist, though it may be achieved in a suitable industry before the end of this century. Any technical development that enables a machine or instrument to dispense with labour is a step in this direction; but whereas mechanization has largely displaced physical effort, the new developments are making automatic some of the work that was formerly done by the human brains. The real distinction, the broadsheet points out, is between automation that displaces muscle and automation that displaces brain, and it is roughly the same distinction as that between automatic operation and automatic control.

The industrial revolution of the nineteenth century was a change towards automatic operation; but mechanization was limited to individual processes, and only in a few suitable trades was it possible to provide automatic links between processes and organized production as a continuous flow. Not until the twentieth century was the idea of producing goods in a continuous flow rather than in batches widely applied, and then at first it was confined to industries in which the movement of materials is straightforward. By the 1920's, some automatic instruments were introduced into most processing industries, and since 1945 the rate of change to automation has quickened, partly because of technical development during the Second World War and partly under the stimulus of the shortage of labour.

Of these developments two are outstanding: the mechanization of the handling of materials in factories by new devices such as fork-lift trucks, and the introduction of transfer machines which perform two or more operations and automatically pass materials from one to the next. The developments in automatic operation, however, while extending the area of application, particularly to the transfer and handling of materials, are not revolutionary but part of a well-established trend. Those in automatic control have been considerably more drastic, and arise largely from the recent and sudden application of electronic methods of control, although electromechanical, pneumatic and hydraulic as well as electronic devices have also contributed. The electronic devices, however, are rapidly gaining in importance and hold out exceptional promise for development in the future.

These devices can plan and control the operation of a machine tool with high precision. They can detect faults in a processed part, and by means of a closed-loop circuit (known as 'feed-back') can communicate the error to the machine and adjust its operation so as to correct the fault. They can integrate the work of individual machines, and the more complex devices can select alternative courses of action according to the instructions fed into them, while finally the possibilities of remote control are extended.

The ability of new devices to detect, communicate and control can greatly reduce the amount of routine brainwork performed in factories, and it is the prospect of rapid technological advance reducing the part played by human labour in the factory to skilled supervision and maintenance that is responsible for excitement about the possibilities of automation. Both the broadsheet and the conference at Margate should dispel any illusions as to the pace with which automation is likely to speed. Not only is much more hard work required before automation becomes general, apart from the limitations set by the availability of the machine tools or the trained engineers required; but also automation has already gone a long way and the number of industrial processes that are ripe for it is limited. More important still, rapid progress with automation depends on complex economic factors to which little thought has yet been given.

It is these economic problems and the social and human implications that require most consideration, and the conference and the broadsheet help to balance and counteract some of the more sensational pictures of the robot factory which have received currency. It is true that, as PEP notes, generally speaking, automation presents no economic problem that has not been created already by the mechanization of processes. There is no conclusive evidence that automatic devices are much more costly to buy than most non-automatic machines; but automation nearly always calls for a large initial outlay and for major changes in production planning.

Computers, for example, have two main advantages: a 'memory' which stores a very large number of facts and gives access to them, or makes computations with them, much faster than is possible with a punched-card system; and secondly, the possibility of automatic links with other office machines, which enable the computer to control the operation of these machines and the passage of information from one machine to another. Continuous research and experiment with computers may make possible all manner of improvements in factory and office methods that so far have been precluded by the inability of human brains to compute the data fast enough or extensively enough. At the same time, it may well be found that the potential saving of labour is limited to firms with large staffs engaged on lengthy mathematical routines. Medium and small firms are scarcely likely to adopt automatic techniques much faster than at present, unless capital costs are greatly reduced by simplification, standardization and other means.

A second problem concerns labour and productivity. As the broadsheet remarks, the post-war trend towards automation would have been much less pronounced but for full employment and the high cost of labour. According to the report of the Committee on Economic and Financial Problems of the Provision for Old Age, the British labour force can be expected to increase only from 23·3 million in 1954 to 24·4 million in 1979. Any substantial increase in living standards must therefore arise from higher productivity, and if the Chancellor of the Exchequer is right in his forecast that the standard of living in Britain can be doubled in that period, the gross national production must be raised by 110 per cent, or allowing for a 10 per cent reduction in working hours, by 123 per cent per man-hour, or 3 per cent a year compared with the present 2·3 per cent and a best long-run increase of only 1·5 per cent a year. If Britain embarks on rapid economic expansion, only a very rapid increase in productivity can avert an acute shortage of labour.

Leaving for the moment the disturbing evidence of the recent strikes that the trade unions are, to say the least, reluctant to face the implications and are looking backwards rather than forwards, the adoption of automatic operation and control may be retarded not merely by hesitancy on the part of firms to invest capital in machinery and equipment which will not be fully or efficiently used, but still more by the shortage of scientists, engineers and technicians competent to undertake the research, design and development that automation will need and will make possible. It was stated at the open day on June 24 of the Culcheth Laboratory of the Atomic Energy Authority that at present the Authority has on its staff only one-tenth of the scientists it needs competent to take charge of a research programme involving direction of the work of a dozen or more juniors. Recruitment for the junior grades is easier, and the director of the Research and Development Section, Mr. L. Rotherham, believes that the difficulty will disappear after some years as existing staff acquire experience.

That, however, is only one example of a shortage of scientists and technologists which is believed to be already hindering the full development of our industrial capacity and which may well be intensified by a continued increase in automation. Since the total population and the labour force of Britain will remain fairly constant, the quantity and variety of scientific and technological skill in the country can only be increased if a much higher proportion of young people qualify in that way than at present. Apart from the diversion of interest among suitable young men and women, this implies an immediate expansion of training facilities, making a heavier demand where shortage is already most acute—in teachers of science.

That is one aspect which makes the question of science teachers and the expansion of technological and technical education in Britain matters of national policy to which the Government should be giving a first priority. Unless this is done, and unless it is done in balance with the expansion of secondary and university education, it is improbable that there will be in the foreseeable future an adequate supply either of newly trained scientists and technologists for such exacting and specialized work, or of technicians and operators generally of the flexibility and adaptability necessary to ensure that full use is made of the services of the more highly trained scientist and technologist.

Automation thus raises the question of education for an era of technological change in the broadest possible context, from that of general education to that of the highly specialized scientist or technologist, from the school to the university or institute of technology, and from the manager to the operator. Nor should the implications in respect of leisure and its use be overlooked. As already noted, increased productivity is likely to be accompanied by an increase in leisure, and this can only be detrimental to a community that is unprepared or unable to make profitable use of that leisure.

No less acute are the problems raised in respect of power. The increase in the consumption of power results chiefly from replacing human energy by machinery, and automatic devices will not directly add much to the demand for power. Indirectly, however, like other means of increasing productivity, they force up the demand for power because they enable the same labour force to produce more goods. Moreover, until nuclear power contributes appreciably to total energy supplies, industrial expansion can only be rapid if supported by large imports of coal and oil; this has been emphasized in the ninth annual report of the National Coal Board, and is confirmed by the decision of the Central Electricity Authority to convert seven of its power stations from coal- to oil-firing and by the warnings given by Sir Claud Gibb and Mr. J. Eccles at the British Electrical Power Convention on June 29.

Here again we are dependent to some extent on the supply of scientists and technologists, for if oil imports are seriously expanded, domestic refinery capacity must be expanded accordingly, with its concomitant demand for technicians and techno-

logists. The over-riding human problems, however, are those of management and labour. Automation will severely test the flexibility of modern management and will involve radical changes in attitude to problems of production engineering and factory layout. There were, indeed, no more promising features of the Margate conference than the awareness of engineers there of the social implications and of their concern to minimize any strain which the change-over might involve for the work-people.

Sir Walter Puckey in his opening address to the conference suggested that work-people would be better off and anticipated no considerable unemployment: more skilled workers would be needed, and also better facilities for technological education and a more effective application of scientific innovations in industry. He emphasized, however, that more flexibility would be required and greater readiness to move from unskilled to skilled occupations. Mr. F. C. Woolland and Lord Halsbury were also reassuring on the point of unemployment; but Lord Halsbury was concerned about possible misfits, and Prof. B. R. Williams stressed once more the importance of education, urging that our present educational facilities are inadequate.

Given, however, this sense of social responsibility on the part of management, scientist and technologist, what of the attitude of labour? Here the conference was a little more hopeful than the recent half-yearly report from the General Council of the Trades Union Congress to the Unions, which has barely begun to face the issues. Mr. Eric Fletcher quite rightly emphasized the need for giving the trade unions full and early information of impending changes, and said that "the Trade Union Congress would co-operate if there was a background of good relations, consultation and redundancy procedures, including control of intakes". Re-training, he said, is a responsibility of management. Apart from recognizing that an increasing amount of shift-work will be necessary, however, Mr. Fletcher gave little indication that the trade unions are thinking deeply about what contribution they can make to a common problem, and how far their own restrictive practices or archaic methods may prevent the community enjoying the full benefit of the new potentialities.

Redundancy, or rather the threat of it, is almost certainly the main cause of alarm and hesitancy among the trade unions, although, as PEP points out, the facts do not suggest there will be serious unemployment. More than half the British labour force is engaged in construction, agriculture, mining, distribution, personal services or self-employed occupations, which are unlikely to become highly automatic in the near future. Local unemployment, however, may well occur, depending on the speed of technical change; and if, as is probable, the change comes slowly, the problem may be solved by slowing down recruitment. National policy, too, could help by scheduling the towns affected as development areas, by persuading firms short of labour to set up branches there and by fostering re-training schemes and greater mobility of labour.

The decisive factor, however, may well prove to be the attitude of the trade unions. It may involve not only open-mindedness to automation and a readiness to recognize the benefits it can bring to labour itself, but also less rigidity to changes in union structure and relations. Apart from the effect of migration of labour to service trades from the general and industrial unions, new unions may perhaps be required to meet the needs of new types of worker. Apart from this, wage-structures are likely to be outdated by automation, and the question of differentials between skilled and unskilled labour could well become acute.

The crucial issues, as PEP emphasizes, are in fact likely to be economic, social and administrative rather than technical; but the key to the solution of all the major problems is in education. In the unions no less than in management, there must be a readiness to look at the problems and issues not from a sectional point of view but from that of the public interest, and to look forward rather than backward. If they are faced responsibly by both sides and there is readiness to work together constructively, discarding obsolete and restrictive practices no longer appropriate in the social welfare State or consonant with the prospect that automatic methods and controls offer the community, the change may well be made without serious unemployment or creating dissatisfaction among the workers.

Clear understanding of the problems on all sides is essential, and the Margate conference should only be a prelude to further discussions and to more carefully planned research. The Department of Scientific and Industrial Research is already collecting information and assessing trends over a wide field of industrial activity, and the report on its findings will be eagerly awaited. Its joint committee with the Medical Research Council, on Human Relations in Industry, has sponsored a small pilot research project in the University of Cambridge into some human and social aspects of introducing automatic control techniques into industry. With this research, however, should go also interpretation and constructive thinking about the many complex issues involved, so that the way may be prepared for effective, enlightened and responsible action. That is a task in which many scientists who are alive to the implications of scientific advance for industry and society could well share.

RADIO TECHNIQUES IN METEOR ASTRONOMY

Meteor Astronomy

By A. C. B. Lovell. (International Series of Monographs on Physics.) Pp. xiv + 463 + 3 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1954.) 60*s*. net.

THE derivation of precise information of meteor paths and velocities by direct visual observation is a task rendered peculiarly difficult by the transient nature and feeble brightness of the luminous paths produced by meteors as they enter the earth's upper

atmosphere. Except during the major meteor showers, comparatively few meteors can be seen per hour in the clear night sky. It is much to the credit of the visual observers that so much should have been learnt in past years of the characteristics of meteors. It is also understandable, with the uncertainties of visual observations and the difficulties of analysis, that controversy should have arisen about the celestial mechanics of meteors.

The mainspring of dispute has been concerned with the sporadic meteors which continue their activity throughout the year. If these meteors move in orbits within the solar system, their velocities at the distance of the earth from the sun must not exceed 42 km./sec., at which limiting velocity the orbits become parabolic; if the velocities are higher, the orbits are hyperbolic and interstellar origin is indicated. There has long appeared to be evidence favouring hyperbolic velocities and culminating in the Harvard–Cornell meteor expedition in Arizona during 1931–33, which led Öpik to infer that at least 60 per cent of sporadic meteors have velocities in excess of the parabolic limit. The evidence has been criticized on the grounds that the observational data were too uncertain, and Prentice and Porter concluded from British meteor data that very few meteors have hyperbolic velocities.

Whereas it might well have been forecast before the Second World War that photographic methods, which had hitherto lacked sensitivity, might be so improved as to provide an important means of obtaining precise data, a result which is now being achieved by Whipple and others at Harvard with the aid of super-Schmidt cameras, it could scarcely have been foretold that the most striking advance would come from radio. Although the meteoric origin of spasmodic increases in ionospheric reflexions had long been suspected, it was the development of radar during the War which enabled Hey and Stewart to prove conclusively that the short-duration echoes seen on long-range radar at metre wave-lengths were from the ionized trails of meteors. Since then, tremendous progress has been made in this field by Prof. A. C. B. Lovell and his group at the University of Manchester. Important contributions have also come from McKinley and Millman in Canada. The radio methods have a great advantage in that observations are unrestricted by weather or daylight. The ascendency of radio techniques could not be more clearly demonstrated than by the fact that Prof. Lovell should be the author of this new book on the measurement of the paths, velocities and mass distribution of meteors, and the derivation of their orbits.

After introductory chapters describing observational principles, Prof. Lovell sets his account of the impact of radio methods on meteor astronomy in the first half of the book against the background of the sporadic meteor problem. The various stages of the controversy are described, with details of methods of analysis and numerous tables from the original papers. Prof. Lovell leads up to recent visual and photographic work and the extensive radio data which have confirmed that very few meteor velocities exceed the parabolic limit. It is feasible that a few may acquire hyperbolic velocities as a consequence of planetary perturbations. It is now almost generally accepted that sporadic meteor orbits are within the solar system.

The second half of the book deals with the less controversial topic of the major meteor showers. It is thirty years since the publication of Olivier's "Meteors", and not only has much new material from direct visual observations since been obtained, but also recent radio and photographic data have greatly refined the determination of meteor stream orbits. Only the radio method is capable of detecting daytime meteors, and a most notable discovery has been the exceptional summer daytime activity. Prof. Lovell's concluding chapters deal with theoretical work on the dispersive influences of planetary perturbations, and cosmological problems of the origin of meteors and the relation between the orbits of meteors and comets.

Prof. Lovell's book is a comprehensive up-to-date account of meteor astronomy. Parts of it are not easy reading; this is largely because the author has included much of the analysis of the original papers in condensed form. The book is clearly set out; there is no difficulty in following the general argument, and one can return later to particular sections for detailed study. As in other branches of science, progress is rapid and there is a profusion of published work. In these circumstances there is much need to have available surveys which co-ordinate past achievements. Especially where there is controversy is it necessary to put the differing views into perspective. The book admirably fulfils this requirement.

J. S. Hey

CAMBRIDGE MONOGRAPHS IN EXPERIMENTAL BIOLOGY

The Physiology of Insect Metamorphosis

By Prof. V. B. Wigglesworth. (Cambridge Monographs in Experimental Biology—No. 1.) Pp. viii+152+4 plates. (Cambridge: At the University Press, 1954.) 12*s.* 6*d.* net.

The Genetics of *Paramecium aurelia*

By G. H. Beale. (Cambridge Monographs in Experimental Biology—No. 2.) Pp. xi+179. (Cambridge: At the University Press, 1954.) 12*s.* 6*d.* net.

THESE two little books are timely, readable, scientifically apt and of just the right length for those who want to know what is going on in a field without being fuddled with technical details. Both authors and editors are to be congratulated on the excellence of these first two volumes of a new series of monographs.

Prof. V. B. Wigglesworth's book contains an introductory chapter on polymorphism and metamorphosis, followed by three chapters on histological changes during moulting and metamorphosis; the physiology of growth and moulting; and the physiology of metamorphosis. The concluding chapter is on differentiation and polymorphism. The approach to metamorphosis is made mainly by a lucid analysis of the humoral mechanisms involved. The hormones "release, control and direct" the inherent capacities of the cells of the tissues, and ultimate understanding of the nature of metamorphosis must depend upon an understanding of the cellular substrate upon which these hormones act. This matrix may perhaps be regarded as a cytoskeleton which may to some extent be continuous even at the supracellular level. Polymorphism is due to alternative reactions of this substrate to alternative humoral (or other) stimuli, and metamorphosis is regarded as a special case of polymorphism.

Dr. G. H. Beale's introductory chapter is concerned with the general importance of nuclear and

cytoplasmic inheritance. He goes on to present certain characteristics of *Paramecium aurelia* which are important from a genetical point of view. He then describes successively the data on 'killer' and 'sensitive' stocks, on the antigens of paramecium and on mating types. His concluding discussion is an attempt to evaluate the general importance of inheritance which is not due to chromosome genes. The subject-matter of the book arises mainly from the work of T. Sonneborn, and Dr. Beale's own investigations have greatly illuminated the genetical problems.

Among the many interesting phenomena, none exceeds in importance the observation that, with a given set of nuclear genes, alternative sets of surface antigens may exist. These sets are mutually exclusive, so that only one set may be found in any given individual. Which set does exist depends upon the previous history and present environment of the animal.

The subject-matter of these two books is quite different; the authors mention neither one another nor one another's most favoured research material. But despite this, both books are important contributions to the general problem of differentiation and modulation. They will be of great interest not only to entomologists and to geneticists, but also to all biologists who are interested in the controlling mechanisms which determine the characteristics of animals.

J. F. DANIELLI

PLANT GROWTH REGULATORS IN AMERICAN AGRICULTURE

Plant Regulators in Agriculture

Edited by H. B. Tukey. Pp. x+269. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1954.) 44*s*. net.

THIS book is in effect a symposium, written by a panel of experts, "for the many who have been puzzled . . . at their seeming inability to grasp the significance of plant growth regulators, what they are, how they operate and where they belong in agriculture". Only the last-named point has been satisfactorily and consistently covered by this book —that is, their place in agriculture. Thus the very wide range of practical application of those synthetic organic chemicals, now unfortunately come to be known almost universally as plant growth 'regulators', has been thoroughly surveyed and our knowledge brought up to date. Comprehensive as this review may be for the American farmer and fruit-grower, its appeal outside the American Continent will be more limited, since little attention is paid to problems from other parts of the world. Thus only one page out of the 224 of text is devoted to weed control in small-grain cereals—a major interest of European farmers. Its value for the non-American is further offset by the exclusive use, in some chapters, of the common American name for crop plants. Thus "snap bean" would mean so much more to a European if its botanical name were appended.

An exposition of the biological significance and mode of action of plant 'regulators' is only spasmodically attempted, despite three somewhat 'bitty' introductory chapters which set out elementary facts and general principles. The consequent confusion in the mind of the layman will not be helped by the fact that the whole polyglot collection of physiologically active compounds are only too frequently considered purely in relation to the general growth symptoms they cause in the plant, and with little regard to the wide diversity of their fundamental actions in the cell. After all, both influenza and a brick on the head will cause a headache.

The main deficiency of this book is therefore the absence of a unifying theme, and this arises from the symposium technique of writing a book. However well meaning an editor may be, it will be difficult for him, short of rewriting whole sections of text, to mould difficult subject-matter such as this into a connected story and to eliminate the overlaps arising between articles of writers with competing interests. It is to be regretted that many of these overlaps were not avoided by allowing the whole of a given field of application to be covered by one author instead of sharing it out between a number of narrow specialists. Some of the contributors have produced excellent articles fulfilling completely the aims set out for the book as a whole. Chapters of this kind are those on parthenocarpy and fruit development in relation to plant regulators; abscission and plant regulators; and plant regulators for weed control in the tropics. Fewer contributions of this quality, each covering one major aspect of plant growth control, would have yielded a much better book.

A final chapter, dealing exclusively with apparatus for the application of chemical growth regulators, will be of considerable interest, although its direct value to the user outside America will depend on the type of equipment available in his country. The book is well produced, and there are many excellent photographic and line illustrations and tables giving details of plant responses to specific regulator treatments in America.

L. J. AUDUS

AMERICAN EPHEMERIS AND NAUTICAL ALMANAC

The American Ephemeris and Nautical Almanac for the Year 1956

Pp. xvii+644. (Washington, D.C.: Government Printing Office, 1954.) 4 dollars.

THIS issue for 1956 of the "American Ephemeris and Nautical Almanac" follows its usual method of arrangement and is in many respects identical with that of the "Nautical Almanac" published in Great Britain. But in other ways it differs from its British counterpart in contents and also arrangement. A few of the points of difference may be noted here.

The American work gives the heliocentric longitude and latitude for all the planets, whereas the British one gives those for Mercury only; the former is a decided advantage, especially for those who have not got a copy of "Planetary Coordinates". The Besselian elements of the eclipses of the sun are given to the fifth significant decimal in the "Nautical Almanac", which is regarded as sufficiently accurate for computational purposes, but the "American Ephemeris" has seven significant figures; the last two figures can have little or no meaning, but this number has appeared for a long time. The same thing applies in other cases; for example, in mean places of stars, both in right ascension and declension, two extra figures are given by the "American Ephemeris" in the seconds. Under sunrise, sunset

and twilight, it supplies the times for each five days, the latitudes corresponding with those of the "Nautical Almanac", but the latter supplies the times for each day, which is a considerable advantage. In addition, for the southern hemisphere, the "American Ephemeris" gives a table with corrections to apply for the corresponding latitude in the northern hemisphere for a date about six months earlier or later. There is a certain amount of inconvenience in turning back the pages for references and, on the whole, the British scheme, while occupying more space, has the advantage of simplicity. Under phenomena, opposition, conjunctions, etc., of planets, the "American Ephemeris" gives the information in a very convenient form by using the symbols for the planets and also for oppositions, conjunction, etc.; but this system does not readily lend itself to showing in tabular form the conjunctions of planets with bright stars, which occupies about half a page in the "Nautical Almanac".

The list of active observatories, which was discontinued in the "Nautical Almanac" after 1941, has been resumed in the 1955 issue, and includes 225 active observatories, but in general is restricted to those observatories the accurate positions of which are required for reduction of observations. The American list contains 223 active and 90 inactive observatories, but includes also the names of many observatories which do not appear in the "Nautical Almanac"—likewise the latter has the names of many observatories which do not appear in the "American Ephemeris". For this reason, each publication may be regarded as complementary to the other with regard to names of the observatories throughout the world.

LAURENTIAN HORMONE CONFERENCE, 1953

Recent Progress in Hormone Research

The Proceedings of the Laurentian Hormone Conference. Edited by Gregory Pincus. Volume 10. Pp. viii+511. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1954.) 9.80 dollars.

THE Laurentian Hormone Conference, inaugurated in 1943, continues to provide a forum for the discussion of current endocrinological research. Vol. 10 of its proceedings gives an account of the meeting that took place in September 1953, and deals with six main subjects: the interaction of neural and hormonal mechanisms; thyroid hormone; comparative endocrinology; protein hormone (in particular, insulin and corticotrophin); the influence of hormones on blood formation; and clinical endocrinology. This is a very wide field for one conference, and the fourteen reports which were prepared as opening papers will not appeal equally to all research workers.

Invertebrate endocrinology was the only topic completely new to the Conference. Here Dr. D. Bodenstein presented a useful review of endocrine mechanisms in insects, and the discussion it stimulated led directly into a paper by Ernst and Berta Scharrer on the hormones produced by neurosecretory cells. This subject is one of the growing-points of comparative endocrinology. By neurosecretion is meant the release by nerve cells of substances in aggregates large enough to be visible in supravital preparations at moderate magnifications. Much evidence, part histological, part experimental, now indicates that the neurons of the hypothalamic nuclei supraopticus and paraventricularis secrete the hormones that up to now have been regarded as the product of the posterior lobe of the pituitary gland. The Scharrers regard the latter as a storage organ, and they also note that the fibres which transmit the neurosecretory material from the hypothalamus to the posterior lobe come into contact with the primary capillary loops of the vessels through which the anterior pituitary receives its blood supply. Accordingly, they suggest that the neurosecretory substance, which is the visible counterpart of the active principle of the posterior lobe, might also be responsible for the chemical control of the secretion of the anterior lobe.

This paper stimulated an interesting discussion. Dr. M. Vogt suggested that, while the hypothalamic nuclei may be responsible for elaborating the posterior lobe hormone vasopressin, oxytocin is produced in the posterior lobe itself. Prof. G. Harris did not agree that the Gomori-stainable material seen in the axons which pass through the median eminence on their way from the hypothalamus to the posterior lobe could be responsible for the activation of the anterior lobe, his reason being that there is no evidence that electrical stimulation of the supraoptico-hypophysial tract will liberate any anterior pituitary hormone. On the other hand, Dr. R. W. Porter, who earlier in the Conference had presented a paper dealing with the part played by central neural mechanisms in the so-called stress response, had reached the apparently contrary view that the median eminence, of which probably the major component is the supraoptico-hypophysial tract, is essential for the transmission of hypothalamic influences to the anterior pituitary. Another question that was raised was whether the same neurones which are involved in neurosecretion also have resting and action membrane potentials, and whether they are capable of being excited by electrical stimuli, or of conducting impulses. To this, as to many other questions, there were no answers.

As one reads through the papers and the record of discussions, one is inclined to feel that far too many points are raised, and far too few answered. One wonders, for example, why the possibility was not suggested that anterior pituitary hypofunction after lesions in the median eminence, like that after stalk section, is due to nothing more specific than the interruption of the gland's main blood supply, which cannot fail to be interrupted either completely or partly when the median eminence is damaged. One wonders, too, why, in the discussion of H. A. Lardy and G. F. Maley's paper on the metabolic effects of thyroid hormone *in vitro*, critical questions about the main hypothesis under discussion should be raised not once, but twice—and still left unanswered. But thoughts like these are perhaps as ungracious, as it is invidious, to direct them to a few out of so many excellent papers. The Laurentian Conference is an intimate affair, almost a club. It meets once a year, and clearly those who attend would not repeat their visits if the free discussion and speculation the Conference allows did not provide a stimulus to their further work. But some may wonder every now and then whether the progress of endocrinology would not be better assured if some of the kites flown at the meeting were occasionally better fashioned, and their strings under more critical control.

S. Zuckerman

Science and Freedom

The Proceedings of a Conference convened by the Congress for Cultural Freedom, and held in Hamburg on July 23rd–26th, 1953. Pp. 295. (London: Martin Secker and Warburg, Ltd., 1955. Published for the Congress for Cultural Freedom.) 21*s.* net.

IN this volume are collected, somewhat condensed and translated, where necessary, the papers presented at the Congress on Science and Freedom held in Hamburg in July 1953, a brief account of which has already been given in *Nature* (**172**, 445; 1953). There are some omissions as, for example, a contribution by Salvador de Madariaga, which is fortunately preserved elsewhere, however, in his "Essays with a Purpose". A preface by Prof. M. Polanyi attempts to give some unity to the proceedings. Homogeneity is most marked in the papers presented in the first two sessions, in which the Congress considered the political and economic framework required for the cultivation of independent scientific research in a free society, and the book is to be welcomed for placing on record in convenient and attractive form the valuable contributions to a topic of current interest from Prof. Polanyi himself, Dr. J. R. Baker, Dr. S. K. Allison, Dr. J. D. Millett, Prof. Jean Thibaud and others and the discussions which followed.

The practical problems of organization and the attendant dangers are clearly displayed and in a way that more than balances any shortcomings that are manifest where the Conference touched on the philosophical implications and in which diversity of opinion and not unity is apparent. Even here, however, the record has its value as a pointer to the hard thinking which is still required from the man of science about the nature and limits of the scientific method, his duties and responsibilities as a citizen and the interpretation and dissemination to the world of the results and implications of his work and thought.

R. B.

Petroleum Microbiology

An Introduction to Microbiological Petroleum Engineering. By Prof. Ernest Beerstecher, Jr. Pp. xv+375. (Houston and New York: Elsevier Press, Inc.; London: Cleaver-Hume Press, Ltd., 1954.) 55*s.* net.

THIS is a courageous but not altogether successful attempt to link microbiology with petroleum production engineering: it covers much borderline knowledge between bacteriology and petroleum geology; but it is weakly linked with engineering, as ordinarily understood in the industry, since, despite the author's obvious sincerity of purpose, it is difficult to see how the "marriage of petroleum engineering and bacteriology" can be realistically successful. When he says that "*microbiological engineering* . . . is a little-known branch of engineering. . . . best visualized as that branch of chemical engineering which employs naturally occurring catalysts as contrasted to inorganic and synthetic catalysts", he is still addressing himself primarily to petroleum chemistry (with which is allied geology in so far as geology is required at the outset) rather than oil engineering.

The author lists the following as fundamentals in this new 'discipline': role of micro-organisms in geology and petroleum genesis; microbial utilization of petroleum hydrocarbons; micro-organisms in oil explorations, drilling muds, oil-bearing rocks and corrosion problems; effects of hydrocarbons on micro-organisms and their influence in manufacturing petroleum products; infectious micro-organisms derived from petroleum and products. Much of this is surely tangential to petroleum engineering. That bacterial forces operate in many and diverse spheres in petroleum science, realized in its more academic pursuits, in abundantly true. But does the petroleum engineer worry about this? If he has not up to now, will his future training perforce embrace this hybridism, and if so, to what practical end? Granted that vista, however, then this book appears at best as guide to a potentially unstable alliance.

H. B. MILNER

Fishes of the Western North Atlantic

Part 2: Sawfishes, Guitarfishes, Skates and Rays. By Henry B. Bigelow and William C. Schroeder. Chimaeroids. By Henry B. Bigelow and William C. Schroeder. (Sears Foundation for Marine Research—Memoir No. 1.) Pp. xv+588. (New Haven, Conn.: Sears Foundation for Marine Research, Yale University, 1953.) 15 dollars.

IN connexion with the establishment of the Sears Foundation for Marine Research at Yale University in 1939, generous funds were provided for publication on an ambitious scale, and excellent use is now being made of the facilities thus made available. Memoir No. 1 of the Foundation is a monographic account of the "Fishes of the Western North Atlantic", and is being published as a series of magnificent volumes written by specialists in their respective fields. Part 1 of this Memoir was published in 1948 and was reviewed in *Nature* (**164**, 766; 1949). Part 2 has now appeared and deals with the sawfishes, guitarfishes, skates and rays. The geographical range of the species described remains essentially the same as in Part 1—that is, the western half of the North Atlantic, including the adjoining gulfs and seas from Hudson Bay south to the Amazon River. All that need be added to what has already been said in the previous review is that the present volume maintains in every way the very high standard set by the earlier part.

G. A. STEVEN

Genetica Medica

1^um^ Symposium Internationale Geneticae Medicae, 6–7 Septembris, MCMLIII. A cura di Luigi Gedda. Pp. xxiii+468. (Roma: Edizioni dell' Istituto Gregorio Mendel, 1954.) 5,000 lire.

TWELVE addresses and eighteen papers of the symposium during September 6–7, 1953, occasioned by the opening of the Mendel Institute for Medical Genetics and Twin Studies in Rome, are presented here together with a discourse by His Holiness Pope Pius XII (in four languages) and an address by the then Prime Minister, Signor G. Pella. Well informed on the facts of genetics, but not so well on those of evolution, the Pontifical discourse constitutes the most valuable feature of this volume. It should be carefully read by all those interested in the social implications of biology.

Among the short papers, a few are of considerable interest. Most of the longer addresses are not. None of the leading human geneticists from Scandinavia, Britain and the United States appears among the contributors. The editorial standards are low. The high price of this volume is probably the consequence of the vast photographic documentation, including also a view of the Institute and two of the opening sessions of the symposium.

BRITISH INSTRUMENT INDUSTRIES EXHIBITION, 1955

THE third British Instrument Industries Exhibition was held at Earls Court, London, between June 28 and July 9. The Exhibition provided a more impressive display of instruments for general use than has previously appeared in Great Britain. Such an exhibition, in fact, does even more than provide a display of instruments, for it gives a measure of the extent to which the use of scientific knowledge has penetrated into industrial and every other major human activity. The main purpose of the Physical Society's Annual Exhibition is to indicate the use made of scientific principles, both old and new, in the design of instruments. The main purpose of the British Instrument Industries Exhibition is to indicate the use which can be made of instruments so designed in the application of scientific principles to utilitarian purposes. Recently a conference was held at Margate, under the ægis of the Institution of Production Engineers, on the automatic factory (see also p. 133), and the recent Exhibition at Earls Court provides abundant evidence that the use of instruments and instrumentation in controlling a very wide range of industrial processes has long passed from the possible to the actual.

One of the first impressions given by any substantial instrument exhibition is the extreme diversity of the various classes of instruments. The 164 firms exhibiting at Earls Court covered almost every type of instrument used in applied science, and in any short account of the Exhibition only general observations can be made. It is apparent that, to a greater and greater extent in the field of industrial control by instrumentation, use is being made of the ability to convert any physical effect into a proportionate electrical quantity, and of amplifying the electrical quantity in a manner which preserves the original characteristics. It is an easy matter to convey an electrical effect from one point to another, and there, by the conversion of the electrical into, say, a pneumatic effect, to arrange that some variation in the original physical quantity measured shall operate, through this double conversion, some mechanical controlling device at some relatively remote position. The intermediate electrical stage comes within the field of electronics, and to the ubiquity of this newest of technologies there appears to be no limit.

One interesting development in the field of automatic control is the appearance of an apparatus for carrying out, completely automatically, the routine chemical analysis and the determinations of quantities, such as *p*H values, of samples of a particular liquid, which might be an integral part in a chemical engineering process, requiring continual control to achieve constancy of composition. The apparatus shown at the Exhibition was designed for a particular purpose ; but, nevertheless, it would appear that a significant start has been made towards the possibility of carrying out 24-hour-a-day sample analyses without any of the drudgery to the human worker which may well accompany such activity.

Much has been said and written in recent times of the gap between discovery in science and application, but there was much at the Exhibition at Earls Court to support the view that the tempo of application is much greater than it once was. It was rather surprising to find that the energy of ultrasonic vibrations is being used very effectively for such operations as drilling, grinding and polishing, and that various varieties of ultrasonic machine tools are in existence. In another direction it is apparent that the development of the instrumental means for making use of the properties of artificial radioactive isotopes has been exceedingly rapid and, in fact, it is hard to see that any sensible gap has existed.

One cannot but reflect, in going around an exhibition of this type, that the scientific curiosities of the comparatively recent past provide the commonplace ingredients of scientific instruments to-day. Ultrasonics have already been mentioned ; but also phosphorescence and fluorescence, paramagnetism of certain gases, piezo-electricity, and many others, all appear as active operating principles in modern instruments. It is apparent that the instrument-maker is far more adventurous than he used to be.

The interest in this exhibition of instruments was, however, by no means confined to the application of new techniques or the further adaptation of old techniques. The engineering measuring instruments on show not only provided an object lesson in themselves of precision engineering, but also indicated most surely that the usefulness of applied optics has by no means been exhausted. Some years ago much criticism was levelled at the appearance and the convenience, as regards use, of British instruments. The range of instruments referred to above and, in fact, the whole exhibition of instruments, indicated how far the instrument industries have travelled since the time when such criticism had any validity.

It was possibly a pity that it was not more widely realized that such an exhibition of instruments as the one so recently concluded has very considerable educational value. On one hand, the changing character of industry, with a trend towards greater and greater automatic and instrumental control, is obviously a matter of great importance, and to a large extent the present state of affairs was epitomized in the Exhibition ; no quicker way can be imagined of obtaining an impression of the extent of the application of science through instrument channels than that provided by a tour of it. On the other hand, there can be no doubt that more and more technicians in industry must be concerned with the use of instruments and, from the educational point of view, it would have been well worth while for industrial concerns to have arranged visits on a considerable scale by their technical personnel to the Exhibition. It was apparent that much greater advantage could have been taken of this possibility, and it is to be hoped that the next British Instrument Industries Exhibition, arranged by the five participating manufacturing associations, will attract a very much greater number of such visitors.

EDUCATION AND TRAINING OF GRADUATE STAFF FOR INDUSTRIAL RESEARCH

THE education and training of graduate staff for industrial research was the subject of the fourth Conference of Industrial Research Directors and Managers, which was organized by the Industrial Research Committee of the Federation of British Industries under the chairmanship of Mr. A. H. Wilson, and held at Ashorne Hill, Leamington Spa, during April 29–May 1. The Conference was attended by more than a hundred industrialists and some forty representatives of science or technology from the universities. Sir Graham Hayman, president of the Federation, acted as chairman, and Mr. George Withers, secretary of the Industrial Research Committee, acted as secretary of the Conference.

In the opening session, Sir Edward Bullard (National Physical Laboratory, Teddington) spoke on staffing and managing a research department. He reminded the Conference that in a little more than thirty years research has grown from the pursuit of the individual scientist into an organized business. But training in science still develops an individual approach, and in consequence there can be psychological difficulties when the young scientist becomes a member of a large research department. This, and many other points in Sir Edward's address, were taken up in later sessions.

First-degree courses in science and technology, which was the subject of the second session, may not now offer much scope for original thought; but Prof. E. G. Cox (Leeds) and Prof. J. A. Pope (Nottingham), the two introductory speakers, were not expected to do more than suggest lines of approach which the Conference might consider in discussion groups. In the event, it proved that the discussion groups had interpreted the subject liberally. Clear thinking, a good grasp of fundamentals, and the ability to write straightforward reports are the usual virtues expected of good first-degree students, while the avoidance of undue specialization and the continual pruning of overloaded curricula are characteristics of good first-degree courses. There was no disagreement.

But, inevitably, the well-known personal qualities which industry, and indeed every employer of graduates, is looking for were reviewed, and there was an uneasy feeling that industry, in its anxiety to find graduates who can readily accommodate themselves to team-work, is placing too much emphasis on a pleasant personality and is in danger of excluding graduates with original minds. After some misunderstanding about the employment of the graduate of modest abilities on development work rather than on research, it was agreed that first-class men are needed for both, but that more men of modest abilities can be employed on development work, once it has been planned, than on research. An interesting point, which unfortunately was not considered in any detail, is the tendency of university courses to develop analytical, rather than constructive, thinking, and it was suggested that the tendency is stronger in pure science than in engineering.

On the whole, there was singularly little criticism of first-degree courses. The Conference was in sympathy with the professor who said that it was not sufficient to allow, as had been suggested, new knowledge to be concentrated by some natural process into simple principles, so lightening the courses. He favoured 'disarmament conferences' for reducing the content of the curricula, at least in engineering. The extension of first-degree courses from three to four years was briefly discussed, but received little support, mainly because the advantages it offers are outweighed by the fact that it will make the shortage of scientists and engineers even more acute.

The Conference found that it was quite impossible to discuss first-degree courses without quickly running up against the problem of the shortage of scientific and technical man-power; indeed, this became the background to all discussions. It is appropriate, as one research director put it, that the Conference should be thinking of ways of improving first-degree courses and the training given to graduates in the universities and in industry; but the most important question at the moment is how to find more boys of the present quality to read science and engineering. The Ministry of Education's report, "Early Leaving", suggests that the possibility of diverting boys from arts to science is not very great. The main hope lies in preventing early leaving. There may be as many as five thousand boys in Great Britain who leave the grammar schools at sixteen, but who would have been capable of studying at least two science subjects up to the Advanced level of the General Certificate of Education. One of the discussion groups directed attention to the great attraction that the Oxford and Cambridge classical scholarships have for the ablest boys, many of whom would have done equally well on the science side; but it was pointed out in the open discussion by a professor of chemistry that industry has it in its power to redress the balance between the number of arts and science scholarships at the universities, if this is thought to be unsatisfactory.

Mr. C. Paine (Imperial Chemical Industries, Ltd.) and Mr. O. W. Humphreys (General Electric Co., Ltd.) were the opening speakers in the third session, the subject being the selection and training of graduate research staff in industry. Mr. Humphreys deprecated what he termed the university scramble, in which firms, including his own, participate by sending representatives to the universities to recruit science and engineering graduates, and it was natural that this should be the starting point for the discussion groups. Everyone thought that the university scramble is unedifying and tending to get out of hand; but scarcely any really practical suggestions for removing the worst excesses were put forward. It was pointed out that a certain proportion of students go up to the universities having already decided on the career they intend to follow. If this proportion could be increased by making industry better known in the schools, selection would be easier. The university appointments boards through careers libraries help the student to make up his mind about careers, and their efforts are, or could be, reinforced by vacation courses, works visits and lectures by industrialists to faculty societies. There are apparently a few research directors who do not join the university scramble, and they experience no greater recruitment difficulties than those who do. The majority, however, look upon the scramble as a necessity, if only of self-defence. After remarking that it is the student that selects the firm, and not the firm the student, the chairman of the session, Sir Norman Kipping, accepted the suggestion of one

of the discussion groups that the Federation of British Industries should examine the problem.

The training of graduate research staff in industry proved to be a somewhat intangible subject. Mr. Paine himself pointed out that, as compared with such matters as human relations in industry, it has not yet received much attention. It is further complicated by the fact that the training varies according to whether the graduate is a scientist or an engineer, and whether he is employed in a large or a small firm. The two-year apprenticeship for engineering graduates who are later to be engaged on research and development was held by some members of the Conference to be stultifying. As for the size of firms, this may be such that no training can be offered, in which case it is necessary to recruit men who have been in other firms. There appears to be nothing comparable for scientists, whose training is organized scarcely at all. Apparently, in certain firms the young graduate is given a range of problems and is permitted to select one for himself; in others, he is given a particular problem in applied research and told that a solution is wanted within a certain time.

The final session was a discussion on postgraduate training at the university, which was opened by Prof. H. W. Melville (Birmingham) and Prof. A. J. S. Pippard (Imperial College of Science and Technology, London), who dealt with the subject from the science and engineering points of view, respectively. The difference in their two points of view was so striking as almost to suggest that there were two quite separate subjects to be considered. Beginning with postgraduate training in science, the first question to be discussed was whether it is necessary for the young graduate to spend three years at the university on postgraduate training. Industry, it was said, can train him in a shorter period, and indeed the postgraduate course formerly lasted only two years. Apparently the length of postgraduate training depends on the particular science in which the graduate is doing research; that it has extended from two to three years is due to the complexity of modern research apparatus and the need for the student to master new techniques. It might be possible to shorten the postgraduate course if the universities could employ technical assistants on the scale on which they are employed in industry.

On the other hand, if it is true that the working life of the industrial scientist in the purely scientific field is about twenty years, even two years of postgraduate training represents 10 per cent of this period, and a longer course has therefore to be justified. It is also reasonable to ask whether the universities are themselves retaining too many young scientists. This question is not a simple one. Figures for the numbers of young science graduates remaining at the universities for further study and research are quite misleading, as these students leave the universities two or three years later and many of them enter industry. The number permanently retained by the universities is very small indeed, probably less than 2 per cent of the output. Further, although the proportion of newly qualified graduates remaining at the universities for postgraduate work may be as high as one in three, this does not mean that invariably all the ablest graduates decide to do postgraduate research. In fact, some of them prefer to go straight into industry.

The discussion on postgraduate training in engineering centred mainly on the need for a small number of young engineers in industry to return to the universities for advanced courses or research. The need is recognized by industry; but the present shortage of scientific and technical man-power makes it very difficult for firms to release staff for long periods. Although industry is hopeful that the position may be easier in the not-too-distant future, at present it favours short courses. Immediate postgraduate training for engineers found little support at the meeting. It was even suggested that the practice of university engineering departments of requiring postgraduate students to have had industrial experience might be followed in other faculties, at least as far as some of their staff are concerned. Nevertheless, there was a plea for an additional year, either as part of the degree course or immediately postgraduate, for the potential research engineer who needs an introduction to modern physics in order that he should understand and be able to use the latest research tools.

The discussion closed with further references to industry's shortage of scientific and technical man-power. First, it was felt that this is being made more acute by the strong attractions of government establishments and of those firms engaged on government-sponsored work. In consequence, the best young scientific brains are being concentrated in limited sections of the national effort to the detriment of the country as a whole. Second, and even more disturbing, it was said that the shortage of scientific man-power will last at least twenty-five years. All employers of scientists—industry and the universities alike—will have to adjust their affairs accordingly.

THE BUBBLE CHAMBER

By Dr. C. DODD

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UNTIL recently, two methods were available for the analysis of collision events produced by high-energy particles: the photographic emulsion reveals the tracks in the form of sensitized solid grains, and the cloud chamber produces tracks in the form of tiny liquid drops in a gas. The third and most recent method of detection, the bubble chamber, exhibits the tracks in the form of strings of tiny bubbles in a superheated liquid, and thereby combines the high stopping power of the photographic emulsion with the easy scanning of the cloud chamber photographs. Moreover, the chamber possesses certain characteristics, such as rapid recycling and freedom from distortion and unwanted background, which are particularly desirable.

Dr. D. A. Glaser[1], of the University of Michigan, discovered in 1952 that a liquid could remain strongly superheated in a clean chamber for several seconds, in the absence of radiation, before the onset of boiling; but that boiling was immediate in the presence of a radioactive source provided the degree of superheat exceeded a certain value. The radiation ionizes the liquid, producing microscopic bubbles carrying like charges, the effect of the charge repulsion being to tend to cause each bubble to increase in size, in opposition to the surface tension effect which tends to make the bubble collapse. For a certain degree of superheat and for a certain degree of ionization, all bubbles, no matter how small initially, grow continuously to a finite size. The degree of superheat is conveniently expressed as the difference between the saturation vapour pressure at the tem-

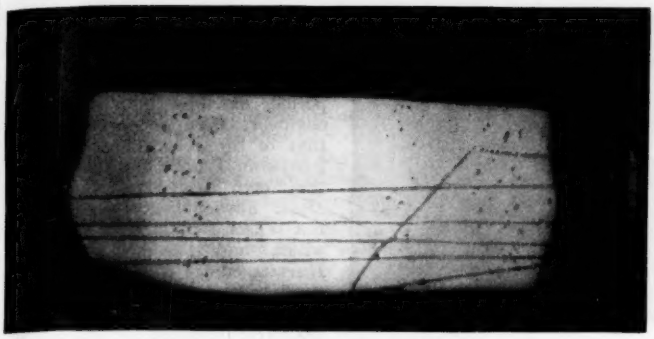

Fig. 1. π-Meson tracks in liquid hydrogen

perature of the liquid and the external pressure on the liquid after it has been expanded into the superheated condition.

In use, the liquid in a smooth vessel is maintained in equilibrium at a temperature much above its normal boiling point by the application of sufficient pressure to the liquid, applied either directly via a piston or through an elastic diaphragm subjected on the other side to gas pressure. On reducing this pressure to, say, atmospheric pressure, the liquid becomes superheated and on the average would remain quiescent for several seconds before violent boiling began. If, during this waiting period, an ionizing particle passes through the liquid, it leaves behind along its track a series of charged bubbles which grow in a few microseconds to a size suitable for photography. Since the bubbles continue to grow very rapidly, it is necessary to use a flash of only a few microseconds duration for the photographic illumination. This rapid growth-rate means that motion of the liquid medium around the tracks can cause only the minimum amount of distortion to the tracks. Moreover, experiments seem to indicate that the charges induced on a bubble persist only for a few microseconds, so that events occurring before and during the expansion do not produce unwanted background tracks. Another important consequence of the short life-time of the charge is that no clearing field is necessary between expansions.

The chamber is reset by re-applying pressure to the liquid, so the complete cycle of events is: (1) expand; (2) particle in; (3) flash; (4) recompress. Appropriate delays are inserted between stages. The time-period of this cycle can be very short; so far, periods as low as half a second have been used and a frequency of 50 per second is contemplated and seems perfectly feasible.

Since the life-time of the charge is so short, the chamber must be in the sensitive condition when the ionizing particle passes through it, so that counter-controlled expansions for use with cosmic rays are impossible. It is hoped, however, to use the chamber for cosmic ray work by passing the liquid continuously through a cycle in which the time during which the liquid is in a sensitive condition represents an appreciable fraction of the total time of the cycle.

The density of the bubbles is a measure of the specific ionization of the particle producing them, and a hundred bubbles per centimetre can be achieved for minimum ionizing particles, so that precise determinations of ranges are possible. The density may be varied by altering the operating temperature, but the rather strong dependence of bubble density on temperature may present a serious obstacle to any attempt to relate this density to the specific ionization of the particle.

The initial experiments using small, cylindrical, all-glass chambers have shown qualitatively the immense possibilities of the bubble chamber. An example of the type of track obtainable is shown in Fig. 1, taken by Hildebrand and Nagle[2] at the University of Chicago. The chamber contained about 15 cm.^{3} of liquid hydrogen at 26° K., at a pre-expansion pressure of 4 atmospheres, and was operated in a π-meson beam.

Such chambers have been designated 'clean' and are characterized by a relatively long waiting time in the absence of radiation. They suffer from the fact that the photographed track has suffered distortion by the curved optical media between the track and the camera; but if a plane window is inserted in the chamber wall in order to get over this difficulty, it is found that boiling always occurs immediately the chamber is expanded into the superheated condition. Fortunately, it is easy to confine this premature boiling to the gaskets used to fix the window to the body of the chamber; and it is then found that if the expansion is made sufficiently rapidly the pressure in the liquid away from the gaskets remains for a few milliseconds at a constant lower value, which is low enough to allow the growth of charged bubbles, provided the temperature of the liquid is somewhat higher than that required for operation of the corresponding clean chamber. The ionizing particles are pulsed to traverse the liquid during this sensitive time, that is, a few milliseconds after the beginning of the expansion. Such chambers are designated 'dirty', and probably because of the higher temperature and pressure at which they operate, the bubbles formed in them grow much more slowly than in a clean chamber, but still fast enough to make track distortion negligible.

Both types of chamber may be biased against recording tracks of weakly ionizing particles simply by reducing the operating temperature slightly, so that only strongly ionized bubbles are capable of continuous growth.

Many liquids have been successfully employed in bubble chambers, including methyl alcohol, diethyl ether, carbon tetrachloride, sulphur dioxide, benzene, pentane, propane, nitrogen and hydrogen. The choice has been governed by the magnitude of the pressure required to keep the liquid from boiling when at the operating temperature, though it is important to avoid the use of liquids of 'modern' origin which may contain radiocarbon atoms. Provided the liquid contains only atoms of low atomic number, the Coulomb scattering is minimized and momentum measurements from the curved tracks obtained in the presence of magnetic fields should be possible. Pentane satisfies these requirements, and Glaser and Rahm[3] have successfully operated a 'dirty' pentane chamber of more than half a litre capacity in the 2-BeV. proton beam from the Brookhaven cosmotron. In Fig. 2, the horizontal tracks mark the proton beam, and other events producing tracks of various bubble densities are visible. The operating temperature was 155° C. and the flash occurred

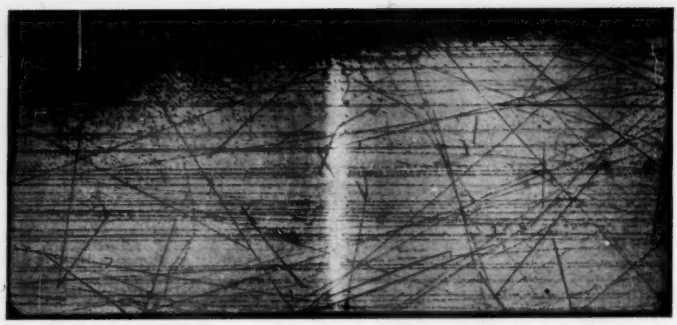

Fig. 2. Tracks produced in pentane by a 2-BeV. proton beam. From Glaser, D. A., and Rahm, D. C., *Phys. Rev.*, 97, 474 (1955)

90 microseconds after the transmission of the proton pulse. Bubbles produced by premature boiling around the top of the observation window have not interfered with the quality of the tracks in the middle of the chamber.

Prof. Luis Alvarez and his group at the University of California have concentrated on the development of the liquid-hydrogen bubble chambers, since this liquid presents a pure proton target. Already, using a 4-in. diameter chamber with a cycling time of only 4 sec., V events and π-μ-electron decays have been photographed, and chambers containing several gallons of liquid hydrogen and operating in a magnetic field are projected for use with the Berkeley bevatron.

[1] Glaser, D. A., *Phys. Rev.*, **87**, 665 (1952).
[2] Hildebrand, R. H., and Nagle, D. E., *Phys. Rev.*, **92**, 517 (1953).
[3] Glaser, D. A., and Rahm, D. C., *Phys. Rev.*, **97**, 474 (1955).

OBITUARIES

Mr. J. S. Wilson

A famous controversy on the design of masonry dams is recalled by the death on May 20, at the age of seventy-nine, of Mr. John Sigismund Wilson. Doubts cast by Prof. Karl Pearson and one of his research students, L. W. Atcherley, on the validity of existing methods of designing such dams led to a decision by the Egyptian Government to postpone the proposed heightening of the Aswan Dam, after Sir Benjamin Baker, their consultant, had demonstrated the behaviour of models, made of stiff jelly. This decision caused widespread discussion and criticism, especially of the use of jelly to simulate masonry, and Wilson, who was then on Baker's staff, made further experiments, in conjunction with William Gore, using models of rubber, loaded to give the effect, to scale, of the density of masonry. By this means he was able to show that the method to which Pearson and Atcherley had taken exception was, in fact, in order; and, as is well known, the Aswan Dam was duly heightened.

The ingenuity displayed in the design of his model, the result of no mere guesswork but of logically pursued reasoning, was typical of Wilson's approach to the kind of problem in which, as a consulting engineer, he specialized—the sort which lies in the common ground between civil engineering and architecture. Born in Cairo on October 13, 1875, he was educated at St. Paul's School, London, and entered the City and Guilds (Engineering) College (then the Central Technical College) in 1893 to take the course in civil and mechanical engineering. He qualified in 1896 and, after a short period in the office of a civil engineer, Burness Greig, entered that of Sir John Fowler and Sir Benjamin Baker, the designers of the Forth Bridge and the Aswan Dam. Fowler died two years later, but Wilson remained with the firm, which had become Baker and Hurtzig, until shortly before the First World War, in the course of which he was associated with the design of directors for anti-aircraft guns. After the War he went into partnership with H. C. Booth (the inventor of the vacuum cleaner) and C. W. Pettit, being concerned mainly with the design of bridges. Since 1932 he had been in practice on his own account, latterly in association with Mr. John Mason.

Wilson took an active part in the endeavours to prevent the demolition of the old Waterloo Bridge across the Thames and was honorary secretary of the conference which, in 1926, sought to preserve it; for which, and other work in the preservation of ancient buildings, the Royal Institute of British Architects elected him an honorary associate. He was a member of the Institution of Civil Engineers, of the Royal Institution and of the Newcomen Society, and was serving on the Council of the last-named Society at the time of his death. He was also an active supporter of the British Association, being secretary of Section G (Engineering) in 1923, recorder during 1929–34 and president of the Section at the Norwich meeting in 1935. He was president of the Old Centralians, the association of former students of the Central Technical College, in 1933, and had received the distinction of Fellow of the College in 1929.

J. Foster Petree

The Hon. Camilla Wedgwood

The Hon. Camilla Hildegarde Wedgwood, third daughter of the first Baron Wedgwood, died on May 17 in Australia. She was born on March 25, 1901. She received her university education at Bedford College, London, and at Newnham, specializing finally in anthropology, which she studied particularly under Dr. A. C. Haddon, to whom she always remained greatly attached. During 1926–27 she became an assistant lecturer in the Department of Social Studies at Bedford College. Then she went out to Australia, in and around which most of her future work lay. For Australia she formed a very great liking and performed much public service there. During 1928–29, as lecturer in anthropology in the Department of Anthropology at the University of Sydney, and since 1936 as honorary lecturer, she taught students with sound scholarship and flashes of brilliant exposition. For some years after 1935 her great capacity and interest in students served her as principal of the Women's College at the University of Sydney—a post to which she brought freshness and originality, having great influence on the students under her charge.

Miss Wedgwood had always wished to undertake anthropological field research. During 1932–34 she held a fellowship from the Australian National Research Council, and worked on Manam, an island

off the northern New Guinea coast. In this relatively isolated community she made a social study with special reference to the life of women and children and to the effects upon the local culture of contact with the culture of white people. She found this research attractive and published interesting material from it. She undertook a further shorter period of research in Nauru in 1935, at the invitation of the Administrator, again primarily to study culture change. When war came she volunteered her services and became a lieutenant-colonel in the Army Women's Services, attached to the Army Directorate of Research. Later she undertook work in Army education, and after the close of the War specialized particularly in the training of education officers for the New Guinea Service, in a post which she held at the Australian School of Pacific Administration. Shortly before she died, her services to the cause of native education in New Guinea were recognized by the Government of the Commonwealth in naming a New Guinea girls' school after her.

Camilla Wedgwood was a cultured woman of striking appearance and many interests, vividly concerned with human problems. She had many friends, who will mourn her early death.

RAYMOND FIRTH

NEWS and VIEWS

Prof. S. J. Davies

PROF. S. J. DAVIES has retired from the chair of mechanical engineering in King's College, London, and has been succeeded by Prof. L. J. Kastner, of the University College of Swansea (see *Nature*, 161, 1004; 1948). Prof. Davies was appointed to the chair at King's College in 1937. He was one of the distinguished band of engineers who came originally from H.M. Dockyard, Portsmouth, where he gained a Whitworth Exhibition. During the First World War he was engaged on the inspection of aircraft engines and later was deputy works manager of the Clyde Engineering Co., Ltd. During 1920–26, he was lecturer in mechanical engineering in Armstrong (now King's) College, Newcastle upon Tyne. He then went to King's College, London, as reader, and in 1937 was appointed professor in succession to Prof. Gilbert Cook; and now, after eighteen years as professor, he has taken up his new appointment as dean of the Royal Military College of Science at Shrivenham (*Nature*, 174, 727; 1954). Prof. Davies is widely known for his researches on oil engines. He has twice been awarded the Herbert Akroyd Stuart Prize of the Institution of Mechanical Engineers, and has also received prizes from the Institution of Automobile Engineers and the Institute of Marine Engineers. In 1951 he was elected a Fellow of King's College, London.

Parasitology at Imperial College, London: Prof. B. G. Peters

DR. B. G. PETERS, head of the Nematology Department of Rothamsted Experimental Station, has been appointed the first professor of parasitology at the Imperial College of Science and Technology, London. From Bristol Grammar School he went to the University, where he graduated with first-class honours in zoology in 1925, and received his M.Sc. in 1927. During 1925–28 he was on the staff of the Institute of Agricultural Parasitology, St. Albans, first as a scholar of the Ministry of Agriculture and later as Grocers' Company research scholar. He obtained his Ph.D. of the University of London in 1928. When the Imperial Bureau of Agricultural Parasitology was started in 1929, he was its first deputy director and remained so until 1932. From then until 1936 he was demonstrator, later lecturer, in helminthology at the London School of Hygiene and Tropical Medicine, and became a recognized teacher of the University in 1935. He returned to the Institute of Agricultural Parasitology in 1936 and, except for two years in Bomber Command Operational Research (1943–45), remained in that Department until, in 1947, it became the Nematology Department of Rothamsted. He succeeded Dr. T. Goodey as head of this Department in 1952. His early research dealt with the taxonomy and bionomics of the vinegar eelworm. Later he turned to the use of statistical methods in helminthological research, and his contributions in this subject have been fundamental in placing experimental helminthology on a sound basis. Since 1948 he has been studying the potato-root eelworm, *Heterodera rostochiensis*, and developing methods for laboratory assays and field-trials of nematicides.

Haskins Laboratories, Inc.: Dr. F. S. Cooper

DR. FRANKLIN S. COOPER has been elected president and director of research of Haskins Laboratories, Inc., of New York, to succeed Dr. Caryl P. Haskins, who has been appointed president of the Carnegie Institution of Washington as from January 1, 1956 (*Nature*, 174, 1172; 1954). Dr. Cooper was born in Robinson, Illinois, in 1908 and graduated from the University of Illinois. He received his Ph.D. degree in 1936 from the Massachusetts Institute of Technology. He was with the Research Laboratory of the General Electric Company until he joined Haskins Laboratories in 1939, where he has been associate director of research. He was senior liaison officer of the Office of Scientific Research and Development during the Second World War, in charge of the exchange of scientific information with the Allies. He has served as consultant to the Secretary of Defense and to the Atomic Energy Commission of the United Nations. He is a member of various scientific and professional societies and of advisory committees of the Massachusetts Institute of Technology and New York University, and is adjunct professor of acoustic phonetics at Columbia University. Haskins Laboratories is a non-profit scientific and educational foundation. Its effort has been in scientific research and research training in selected borderline fields.

Conference on the Effects of Nuclear Weapons

A CONFERENCE of scientists is to be held during August 3–5, under the auspices of the World Association of Parliamentarians for World Government, to discuss the nature and extent of the danger to mankind involved in experiments with nuclear weapons and their possible use in warfare. The meeting will take place in the County Hall, London.

The British Committee for the Conference is: Lord Boyd Orr (*chairman*), the Right Hon. Walter Elliot, Earl Russell, Gilbert McAllister, G. V. Morris, Prof. J. Rotblat and Henry Usborne. The conference fee for delegates (members of Parliament and scientists with a recognized qualification) is £3 and for observers £2. Particulars can be obtained from the Secretary-General of the World Association of Parliamentarians for World Government, 21 Hampstead Lane, Highgate Village, London, N.6.

Colonial Development Corporation: Report for 1954

In the annual report and statement of accounts of the Colonial Development Corporation for the year ended December 31, 1954 (pp. 50. London: H.M.S.O., 1955; 2*s*. net), staccato presentation and condensation have been carried to a point which make it difficult to gain a clear picture of the work of the Corporation and its relation to Colonial development generally. Financial results indicate that the Corporation's net loss on the year has been reduced to £222,353; but, in spite of the abandonment of unsound projects, the Corporation at the end of 1953 still had a cumulative deficit of £9·7 million, of which £6 million represented losses on projects and activities begun before December 31, 1950, and afterwards abandoned; until satisfactory relief is given the legacy of the past will remain a factor in policy. Seven new projects were commenced during the year, and one—the experimental Yundum farm, on land originally cleared for the Gambia poultry farm—was abandoned, leaving the Corporation with fifty-six continuing projects and investigations. At the end of the year the Corporation was managing directly, or through controlled companies, sixteen trading projects with an aggregate turnover of more than £6 million a year, selling such diverse commodities as beef and hides, rice, bananas, rubber, hemp, timber, cement, electric current, housing finance and hotel accommodation. Heavy expenditure is still carried on many projects which are sterile until communications are provided, and other projects have to bear heavy public utility expenditures which by other capitalization can outweigh the marginal risk in which the Corporation deals. The report emphasizes that, although the staff is still a nucleus and requires strengthening, it is competent and reliable within that limitation, and acknowledgment is also made of the services of the scientific panel. Little indication is given of any scientific work under the Corporation; but the report notes that trials with ramie, citrus and cocoa in British Honduras have yet to disclose the best way to stimulate the economy of the territory.

Diploma Awards in Technology

It was announced in the House of Commons on July 14 by the Minister of Education, Sir David Eccles, that a National Council of Diplomas in Technology in Technical Colleges is to be established, and that Lord Hives, chairman and managing director of Rolls-Royce, Ltd., has been appointed chairman of the Council. Awards will be available to students in technical colleges in Britain who successfully complete technological courses approved by the Council. It is intended that the diploma award shall be comparable in standard with a first degree of a university. The question of a post-graduate award is to be considered later.

Higher Technological Education in South-east England

The sixth annual report of the London and Home Counties Regional Advisory Council for Higher Technological Education, covering the year ended August 31, 1954 (pp. 40; from the Council, London, 1955), apart from a brief account of the sixth annual meeting on July 15, 1954, is concerned chiefly with activities related to particular industries. In general policy the Council decided to support the National Advisory Council's scheme for creating and administering awards in technology, but made the proviso that reconsideration of the title of the award and further consideration of a title for a higher award should be made, and that the relationship of the two boards of studies (one for engineering and the other for technologies other than engineering) and of the details of their respective constitutions should be clarified. The Council has also commented on the 'sandwich' principle in general but, while generally approving the principle of combined college and works training in about equal periods over three or four years, regards it as likely to be only of limited application in the London and Home Counties region except in electrical, mechanical and production engineering. All but one of ten such courses in operation during 1954–55 are in engineering. Of the Council's activities to assist technical training for particular industries, it can only be said here that the very variety of trades to which the word 'technology' is, at least by implication, applied makes it understandable that there should be such slow progress in the expansion of technological education. There is little or no indication in this report of any clear distinction between a technique and a technology, and, while that confusion persists, progress is bound to be impeded.

The Botanical Society of the British Isles

Membership of the Botanical Society of the British Isles has reached a total of a thousand. This means that membership has doubled since January 1, 1950, when it stood at 498, and during this period the scientific standard of the Society's periodicals (*Watsonia* and the *Proceedings*) and of the meetings (especially the conferences and the annual exhibition meetings) has been raised to a high level. The Society is descended from "The Botanical Society of London", founded in 1836. It is evident from this long history that there has never before been a time when interest in British field botany would have supported a membership approaching the present size at the scientific level at which the Society aims. Moreover, some recent developments, such as the Distribution Maps Scheme and junior meetings for students, are being supported by many people who are not at present members of the Society.

Kilogram Standard Weight for South Africa

An international standard 1-kilogram weight has recently been made for the South African Government by the firm of L. Oertling, Ltd. (St. Mary Cray, Orpington, Kent), the same company that made last year a primary standard 10-tola weight for the Government of Pakistan (*Nature*, **174**, 296 and 1094; 1954). The weight is made from an alloy containing 90 per cent platinum and 10 per cent iridium, supplied by Johnson Matthey and Co., Ltd. (Hatton Garden, London), and is in the form of a cylinder of equal diameter and depth with a slightly concave

base so that the weight rests on an annular ring. The tolerance specified was ± 0·15 mgm. on the finished mass, and the weight has been certified by the International Bureau of Weights and Measures at Sèvres, near Paris, as being well within the permitted tolerance, thus making it one of the World's International Kilograms. A weighing accuracy of two parts in 10^8 was necessary. The manufacture of the weight involved a protracted series of accurate weighings coupled with the removal of successively smaller and smaller amounts of material from the weight, so that the correct nominal mass and the optimum surface finish were achieved simultaneously.

Standard X-Ray Diffraction Powder Patterns

THE fourth in the series of "Standard X-ray Diffraction Powder Patterns", prepared by the National Bureau of Standards, Washington, D.C., has recently been published (N.B.S. Circular No. 539; pp. 75. Washington, D.C.: Government Printing Office, 1955; 45 cents); in it are presented data for five elements, thirty-five organic compounds and two intermetallic compounds. The patterns are recommended to replace ninety-five cards in the card file of the American Society for Testing Materials and, in addition, seven compounds (gallium oxide, neodymium oxide, strontium chloride, thallium iodide, silver oxynitrate, aluminium antimony and indium antimony) which are not represented in the file are included. The card file serves as a system for the identification of unknown crystalline materials based on the three strongest reflexions of each material. In the new publication a comparison is made between all powder diffraction data available for each of the substances reported. The samples used by the Bureau to make the patterns were special preparations of exceptionally high purity obtained or prepared only in small quantities, and the purity of each sample was determined by spectroscopic or chemical analysis. A Geiger-counter X-ray diffractometer was used, and the *d*-spacings were assigned Miller indices by comparison with calculated patterns. The densities and lattice constants also were calculated, and the refractive indices were measured wherever possible. Detailed references are given.

Systematic Anatomy of the Monocotyledons

THE project of preparing a comprehensive book on the systematic anatomy of the Monocotyledons, parallel to that already available for the Dicotyledons, and recent investigations towards that end, have been discussed by C. R. Metcalfe (*Kew Bull. Misc. Inf.*, No. 4, 523; 1954). Such a work of reference is badly needed and is now one of the main undertakings in the Jodrell Laboratory of the Royal Botanic Gardens, Kew. The numerous scattered contributions on monocotyledon anatomy have already been indexed in preparation for the new work. It is realized that the proposed survey must necessarily be of a somewhat general character, based on the existing literature, supplemented by the new investigations of different families now being undertaken at Kew and elsewhere. The main objects of the book will be to serve as a dictionary in which the reader can quickly ascertain what is known about any particular plant, and, by reference to the literature, follow up any particular aspect of plant structure; to serve as an aid in identifying economic materials of monocotyledon origin; and to advance taxonomic studies of the Monocotyledons and to throw light on their phylogeny. An account is given of recent progress in the relevant anatomical investigations at Kew, reference being made to the Gramineae, Alismataceae, Xanthorrhoeaceae, Zingiberaceae, and to such topics as the nature of the tracheal elements in different groups. It has been recognized that anatomical studies of this kind have revealed characters which are important in the broad taxonomy of the group; but the author rejects the view that our knowledge is already so complete that it is scarcely worth while pursuing the subject further. On the contrary, he considers it probable that fuller comparative anatomical studies will ultimately contribute to an improved classification, and will help to make possible a much more comprehensive understanding of the physiology and form of the flowering plants than we yet possess.

Soils of the Glastonbury District of Somerset

THE soils of the Glastonbury district of Somerset are the subject of a recent Memoir of the Soil Survey of Great Britain, by B. W. Avery (pp. 131+4 plates. London: H.M.S.O., 1955; 15*s*. net). The area mapped comprises Sheet 296 of the Ordnance Survey and is of interest because it includes some of the 'teart' pastures of Somerset, where cattle are liable to suffer from a distinctive form of scouring, an ailment now known to be due to excessive amounts of molybdenum in the herbage. These pastures are confined to calcareous soils developed from the Lower Lias clays. The area of 216 square miles described in the memoir lies in the centre of Somerset and is predominantly rural in character. Calcareous soils form the largest group (36 per cent), while the brown earth and gley groups together account for a further 49 per cent of the soils of the area. The remaining soils are chiefly organic (13 per cent) developed over peat and are practically confined to the Sedgemoors. The concluding chapter on the agriculture and land use of the area is concise and well written and will be of more general interest. Descriptions of typical profiles and analytical data are provided in an appendix. There is also a glossary of technical terms which makes the report more palatable to the non-specialist.

Rugby School Natural History Society

THE report of the Rugby School Natural History Society for 1954—its eighty-eighth issue—again shows the valuable work done by school natural history societies in building up and sustaining interest in living things. Some years ago the Society decided to produce a complete natural history of the Rugby District, and 1954 saw the completion of the first instalment—the "Flora". The value of the work has been recognized by the Royal Society with a grant of £50 towards the cost of publications. Among other activities were a series of experiments to determine the feeding habits of certain freshwater animals in a local pond; an investigation into the importance of the cow parsnip (*Heracleum sphondylium*) in the economy of various insect species; and an account of the archæological section's digging at the site of Brownsorer in order to elucidate the date and purpose of the earthworks that are scattered around the village.

Polish Academy of Sciences: *Quarterly Review of Publications*

THE first issue of the *Quarterly Review of Publications*, published by the Polish Academy of Sciences, Warsaw, covers the period April–June 1954

and includes abstracts from a total of 112 monographs and periodicals published by the Academy and other associated bodies in Poland. Titles are given in the original version, followed by an English translation. Bibliographical data are grouped under the various subjects, which number thirty-six in all and include, besides the conventional scientific and technical ones, such subjects as economics, history, law, linguistics, literature, oriental studies and philosophy. Under agriculture, four journals are listed, two of them being new—*Postępy Nauki Rolniczej* and *Roczniki Gleboznawcze*—while under archæology various publications are given of the Warsaw Society of Science and Letters, the Polish Archæological Society and the Institute of the History of Material Culture. Papers which have appeared in *Urania* and in *Postępy Astronomii* are included in the astronomy section, and under biology close on one hundred papers published in the *Bulletin de l'Académie Polonaise des Sciences, Ekologia Polska, Folia Biologica, Kosmos, Wszechswiat* (The Universe) and *Przegląd Antropologiczny*. The chemistry section contains mostly papers published in *Roczniki Chemii* and *Wiadomosci Chemiczne*. Two new books on Poland of the Renaissance period and numerous papers published in *Kwartalnik Historyczny* and *Przegląd Historyczny* are listed under history, and under linguistics is mentioned a new "Dictionary of Old Polish", which is an account of words and their forms as preserved in manuscripts from the earliest times up to 1500. In the literature section there are several new essays on Prus, Zeromski and some contemporary writers. Under mathematics is a new journal, *Annales Polonici Mathematici*; under medicine a number of new monographs and a new journal, *Postępy Wiedzy Medycznej*; and under oriental studies another new journal, *Przegląd Orientalistyczny*. In the section headed philosophy is listed a new joint publication by several authors on the "Problem of Humanism", and in that on physics are a large number of original papers which appeared in the *Acta Physica Polonica, Bulletin de l'Académie Polonaise des Sciences, Classe troisième*, and *Postępy Fizyki*. The physiology and biochemistry section lists the contents of the relevant issues of two journals (see *Nature*, April 16, p. 667), and in the zoology section there are several new monographs including one on Caryophyllaeidae in Poland.

Progresso Terapeutico: a New Italian Medical Review

A new Italian quarterly medical review, *Progresso Terapeutico*, has recently been started, edited by Ottavio Carlotto under the direction of a scientific committee. The first issue (January–March 1955; from Via Ascoli Piceno 19, Rome; price not stated) consists of forty-eight pages, the first twenty-four of which are devoted to articles by G. Luciani, on recently discovered vitamins; by V. Romeo, on an unusual hæmatological reaction (reduction of the number of granulocytes) occurring in the course of tonsillitis; by C. Pagliuca, on erythromycin derived from *Streptomyces eritrens*; and a report on the conference held by Prof. R. Lattes in the medical clinic of the University of Milan on smoking and cancer of the lung. The rest of the review gives accounts of the second congress of the Italian Society of Chemotherapy and of the eleventh national reunion of the Italian Metapsychic Society; scientific notes; short abstracts from Italian and other medical journals; a note on chronic bronchitis, bronchiectasis and *cor pulmonale*; short reviews of books and papers; various notices; and a page, by L. Vitale, of epigrams against medical men.

Transvaal Museum, Pretoria: *Bulletin*

For many years the results of the researches of the staff of the Transvaal Museum, Pretoria, have been published in their own *Annals and Memoirs*. Now a *Bulletin* (No. 1, March 1955; pp. 8) has been issued to cover the more popular activities of the Museum. The first number contains a useful note on trapping butterflies, descriptions of expeditions to Mocamedes and Northern Bechuanaland and details of recent acquisitions in the Museum.

Electrical Standards and Metering: Exhibition in the Science Museum, London

A special exhibition on electrical standards and metering has been opened at the Science Museum, London, to coincide with the current meeting of the International Electrotechnical Commission and will remain open, admission free, until October 31. The exhibition is intended to show the general public the care which is devoted to the accurate calibration of electricity meters, though there are, in addition, more specialized exhibits which will appeal to those directly concerned with the problems of metering bulk supplies of electrical energy to large industrial and commercial undertakings. In the section dealing with the origin and derivation of the various electrical units, an exhibit of particular interest is the complete set of the original units of resistance which were made in 1864 for the British Association and constitute the oldest set of accurate electrical standards now in existence. These 'B.A. units' have been stored for many years at the National Physical Laboratory, Teddington, and the Science Museum hopes to acquire them and incorporate them in its national collection of historic scientific apparatus.

Mineral Resources Policy in Great Britain: Symposium in London

The Institution of Mining and Metallurgy is arranging a symposium on mineral resources policy in Great Britain, to be held in the hall of the Royal Society of Arts, John Adam Street, Adelphi, Strand, London, W.C.2, on September 22. The object of the symposium is to allow fuller discussion of the proposals contained in a paper on "Mineral Resources Strategy", originally read by Mr. D. A. Oliver (director of the Group Research Centre of the Birmingham Small Arms Co., Ltd.) at a conference on research and industrial productivity held in London in November last year. The theme of Mr. Oliver's paper is that minerals productivity will be increased if greater co-ordination of the right kind can be established between all the interested parties—geologists, mineral dressing and mining specialists, mining and finance houses, mining engineers, local authorities, fabricators and users, and finally the Government. An Office of Materials Mobilization has been established in the United States with similar objects, and proposals for setting up a comparable organization have been put forward in Great Britain from time to time. Five other papers have been submitted to the symposium, dealing respectively with mineral development and research in the United States and Canada; the mineral industry in East Africa; Canadian aids to its mineral industry; some economic considerations in a British mineral resources policy; and a proposal for a central ore-dressing laboratory. These papers and that of Mr.

Oliver will be circulated in advance and will form the basis on which the discussions can proceed. The meeting will be open to non-members of the Institution. Further information can be obtained from the Secretary of the Institution, Salisbury House, Finsbury Circus, London, E.C.2.

Vitamin E : Congress in Venice

THE third International Vitamin E Congress will be held in Venice during September 5–8, in the premises of the Cini Foundation on the Island of San Giorgio Maggiore. Each day will be devoted to a particular topic, namely, the relation of vitamin E to the following: metabolic processes; other vitamins, hormones and enzyme systems; cardiovascular system; and nervous and muscular system. In the mornings, reports will be given on experimental studies, and in the afternoons, papers on clinical investigations will be read and discussed. The official languages of the congress will be English, French, German, Italian and Spanish. Further information can be obtained from the secretary, Prof. Emilio Raverdino, Via Pietro Verri 4, Milano.

Correlation between Calculated and Observed Stresses and Displacements in Structures

A CONFERENCE on the "Correlation between Calculated and Observed Stresses and Displacements in Structures" will be held by the Institution of Civil Engineers in its premises at Great George Street, Westminster, during September 21–22. Twenty papers will be presented and discussed in the following four separate sessions: philosophy and techniques of testing; steel structures; concrete structures; and earth pressures and movements. The papers to be presented will be printed in a preliminary volume available in August, and a final volume containing the discussions at the conference will be printed towards the end of this year. The registration fee of £2 will include a copy of the preliminary and final volumes of the proceedings, and extra copies will be obtainable at 30*s.* a set. Application forms, to be returned by August 1, and further information can be obtained from the Secretary of the Institution, Great George Street, Westminster, London, S.W.1.

Information Theory : Symposium in London

THE third London Symposium on Information Theory will be held in the Royal Institution, 21 Albemarle Street, London, W.C.1, during September 12–16. Each day will be devoted to a particular topic as follows: fundamentals; coding, taxonomy, etc.; language analysis and mechanical translation; meaning and the human senses; and behaviour and its mechanism. Copies of the papers will be circulated in advance. The registration fee for the conference is £2 10*s.* Further information can be obtained from Dr. Colin Cherry, Department of Electrical Engineering, City and Guilds College, Exhibition Road, South Kensington, London, S.W.7.

Society for Applied Bacteriology : Officers

FOLLOWING the annual meeting and summer conference of the Society for Applied Bacteriology, held in Cambridge during July 3–6, the following were appointed officers of the Society: *President*, S. B. Thomas; *Secretary*, G. Sykes (Microbiology Division, Boots Pure Drug Co., Ltd., Nottingham); *Treasurer*, C. S. Miles; *Editors of the Journal of Applied Bacteriology*, Dr. S. E. Jacobs and Dr. L. F. L. Clegg; *Publications Manager*, E. A. Whitlock; *Advertising Manager*, E. J. Mann. Dr. Ella M. Barnes, H. B. Hawley and W. H. Pierce were elected to the Committee in succession to Dr. L. A. Allen, Dr. M. Ingram and D. A. McKenzie, who retired by rotation.

Announcements

PROF. C. VAN RIET LOWE has retired from the directorship of the Archæological Survey of the Union of South Africa, Johannesburg, and has been succeeded by Mr. B. D. Malan, of the University of the Witwatersrand. Prof. van Riet Lowe will continue to hold the chair of archæology in the University of the Witwatersrand.

IN connexion with the opening of a new Schmidt telescope at the Hamburg Observatory, a symposium will be held there during August 19–20 on the problems, methods and astronomical programmes relating to such telescopes. Further information can be obtained from the Hamburger Sternwarte, Hamburg-Bergedorf.

THE annual general meeting in the United States of the Association for Computing Machinery will be held at the Moore School of Electrical Engineering, University of Pennsylvania, during September 14–16. Further information can be obtained from Sidney Kaplan, Radio Corporation of America, Computing Systems Engineering, Building 13-2, Camden 2, N.J.

THE Society of Dyers and Colourists is holding a symposium on "Bleaching, Dyeing and Finishing To-day" during September 13–17 in the Northern Counties Hotel, Portrush, Northern Ireland. This will be the first time that the Society will have held a symposium in Northern Ireland. Further information can be obtained from the General Secretary of the Society at Dean House, 19 Piccadilly, Bradford 1, Yorks.

THE Institute of Rural Life at Home and Overseas is holding a residential course of rural studies at the Essex Institute of Agriculture, Writtle, near Chelmsford, Essex, during August 28–September 10. The course will cover a wide field of overseas problems, as well as local ones, and will be particularly useful for missionaries, social workers, Colonial students and other visitors from overseas. The fee for the course is 19 guineas. Further information can be obtained from the Secretary of the Institute at 59 Bryanston Street, London, W.1.

THE fifth congress on biological rhythm arranged by the Societas pro Studio-Rhytmi Biologici will be held in the Department of Anatomy of the Caroline Institute, Stockholm, during September 15–17. The three main themes to be discussed will be rhythmical phenomena in the nervous system, cybernetics, and rhythm and industrial medicine. Further information can be obtained from the Secretary of the Fifth Rhythm Congress, Societas pro Studio-Rhytmi Biologici, Anatomiska Institutionen, Karolinska Institutet, Solnavägen 1, Stockholm 60.

THE University of Padua is offering a Gabriella Zuccari scholarship of 300,000 lire for research of at least six months duration at the Zoological Station, Naples, during the academic year 1955–56. The scholarship is open to any person who wishes to undertake research in zoology, comparative anatomy, physiology or embryology, and it may be renewed up to a maximum of three years. Application forms, to be returned by October 31, and further information can be obtained from the Secretariat of the University of Padua.

THE ENGINEER AND THE CONSERVATION OF NATURAL RESOURCES

IT has now become a truism that the history of man's achievement has been his constant effort to master the forces of Nature and the tremendous resources that are his inheritance. But in his endeavour to fulfil this aspiration, which has never been entirely realized, man has disturbed the delicate balance maintained by Nature in guarding her resources and has created the problem of conservation of these natural resources, the depletion of which is, in some quarters, a matter of growing concern. Such was the subject of the first Graham Clark Lecture, delivered to the Institution of Civil Engineers on May 4 by Sir Harold Hartley. The Lecture is given in honour of the late Graham Clark, who for many years was secretary of the Institution and who strove to promote co-operation between engineering societies both in Britain and abroad; after paying a brief tribute to him, Sir Harold turned to the main topic of his address, a subject which, while it has been dwelt upon previously in one way or another, he approached from a novel direction in stressing the importance of the engineer in contributing to the conservation of the great bounty of Nature.

The greatest resources upon which our civilization depends are soil and water, and Nature has always jealously guarded these and maintained her equilibrium therein; but man, when he appeared on the scene, upset this by the clearing of land for cultivation and dwellings, creating, as a result, problems of conserving these two most valuable resources. Irrigation and storage schemes have constituted one attempt to meet these problems, from the great systems of the ancient empires to the tremendous multi-purpose projects of to-day, embodying the storage of water for irrigation, hydroelectric power, flood control and transportation, such as the Tennessee Valley Authority Plan. Such facilities as improvements in dam and canal construction, the use of hydraulic models, geophysics and soil mechanics have aided the solution of many problems; but the inexorable forces of Nature are always at work, and man is reminded of this by the appearance of new difficulties such as the silting up of reservoirs or increasing salinity in irrigation systems by lack of sufficient water. In some areas shortage of water is a grave problem, and the future of water supplies is dependent on the wider acceptance of such techniques as the re-use of water by the treatment of sewage and effluents, or the distillation of sea water, added to which is needed a more thorough knowledge of the behaviour of ground water. Again, where land is valuable, coastal and inland erosion are being curtailed and land is being reclaimed from sea and marsh as in Holland and in the Fens in Britain. In all these efforts, the main problem is to maintain cultivation without loss of fertility in the soil, and in this regard we are gradually learning how to make use of Nature's gifts.

Sir Harold went on to remark that, next to soil and water, energy forms the greatest need of mankind; the consumption of energy per capita determines the standard of living of a country. Here the engineer's role is to increase the efficiency of combustion devices and so effect a saving of such sources of energy as coal and petroleum products, since these provide mankind with a tremendous amount of energy; but with the advent of nuclear power man will be able to utilize these more for their chemical potentialities than before.

The conservation of raw materials and their economical use form one of the engineer's most notable contributions to-day. New methods of treating raw materials, such as the economic recovery of low-grade ores, have advanced greatly during the past two decades. In the field of structural engineering, a saving of steel has been effected by the increasing use of concrete and by new concepts of structural analysis, such as the plastic method of design, developed in the Engineering Department at Cambridge, with the advance of new structural steel forms. Improvements in the working of metals and developments in lubricants and anti-corrosives have resulted in further economies. Finally, there is the greatest economy of all, that of human labour by the use of automatic control and the possibilities of the automatic factory; here Sir Harold directed attention to the fact that, while control engineering is making great advances abroad, more recognition needs to be shown in Britain in this field.

In his closing remarks, Sir Harold drew three important conclusions: first, progress needs specialization, coupled with a wide outlook and a knowledge of other fields of endeavour, for too much specialization is dangerous. Secondly, we must work more closely with Nature in a new partnership made possible only with the great forces that she encompasses. Finally, there is in each generation a limit to what is possible, and it is imposed by the resources and skills which are available to man and which, with their uneven distribution, must be used to their best advantage with careful planning, for our convenience.

One may feel inclined to think of this Lecture as a catalogue of attainments, but it was, in fact, more than that; it was a timely warning. While man has a creditable record of achievement to look back upon, he still has to come to work more with Nature, for he cannot control her. Only then will he be able to use and enjoy the great endowment of her resources which has come to be his heritage.

E. T. Holmgren

TOWNS AND THEIR HINTERLANDS

SINCE its inception in 1941, the Research Maps Office of the Ministry of Town and Country Planning, now part of the Ministry of Housing and Local Government, has carried through a remarkable programme of work. In particular, it has prepared with the joint sponsorship of the Department of Health for Scotland the now extensive series of National Planning maps on the uniform scale of 1 : 625,000, or approximately ten miles to the inch, each in two sheets covering England, Wales and Scotland. Civil servants' work in anonymity; but it is not difficult to detect the skill and care of the guiding hand of Dr. E. C. Willatts, who has been in charge of the work for most of the past fourteen

years. Many of the maps have marked new departures in cartography, and this is certainly true of the latest addition to the series depicting towns and their hinterlands*. It is obvious that every market town exercises a considerable influence on the surrounding countryside, but this 'hinterland' is difficult to define and to delimit. It has little or no connexion with administrative units, and yet is obviously of great importance in planning the social services to be provided by the urban centre as well as of no little interest in the organization of retail trade and services.

The criterion here adopted owes much to the pioneer studies of F. H. W. Green, and is that of bus services. A town or village is defined as a centre if it has operating from it at least one bus service which serves no place larger than itself. The centres with populations over three thousand (using the 1951 Census) are represented by an orange circle proportional to the population, surrounded by a green circle proportional to the population of the hinterland. Firm lines mark—perhaps with a firmness their shadowy nature does not warrant—the boundaries of the hinterlands. In general terms, the people living within a given hinterland normally visit the centre shown for shopping, entertainment, cultural and professional services.

So much of the extensive programme of town and country planning to which Britain is committed is of necessity based upon very slight factual knowledge, and such attempts as are illustrated by this map to introduce a scientific objectivity are entirely praiseworthy. Though the centres are smaller and the hinterlands are larger in the sparsely populated parts of the country, what strikes one is the relatively even spacing of the centres. In days of old when people walked to market (or the richer rode on horseback), the effective hinterland of a market town had a radius of about four miles. It still seems to be only about six miles. Over much of England the centres tend thus to be ten to twelve miles apart. It is more in Wales and Scotland.

L. Dudley Stamp

* Local Accessibility: the Hinterlands of Towns and Other Centres as determined by an Analysis of Bus Services. Sheet 1: Scotland and N. England. Sheet 2: the Remainder of England and Wales. Compiled by the Ministry of Housing and Local Government from information supplied by the Bus Operators and the Ministry of Transport and Civil Aviation. (Chessington, Surrey: Director General of the Ordnance Survey, 1955.) 5s. per sheet.

LIBRARIES OF THE DYESTUFFS DIVISION OF IMPERIAL CHEMICAL INDUSTRIES, LTD.

NEW BUILDING AT BLACKLEY

THE new library building of the Dyestuffs Division, Imperial Chemical Industries, Ltd., was opened at Blackley, Manchester 9, on June 27 by Mr. Clifford Paine, development director of Imperial Chemical Industries, Ltd., and until recently chairman of the Division. Mr. Paine said that a first-class scientific library is the core of a research organization and expressed the hope that the new building will provide the conditions which will stimulate creative work in the minds of those who are expected to make the discoveries of to-morrow. Although the value of library and related services has long been recognized in the Dyestuffs Division, it is only with its removal in May 1955 to the present building that the Main Library of the Division has been housed in premises worthy of its holdings and the services provided. The Divisional libraries hold a total of nearly forty thousand bound volumes (of which about half are periodicals), together with about twenty thousand pamphlets and miscellaneous publications, some fifteen hundred bound volumes of patent specifications and several hundred unbound specifications. About half the total collection is housed at Hexagon House, Blackley, where the collection in organic chemistry and related subjects is probably one of the finest in Great Britain. More than a thousand current periodicals are taken, and about half of these are bound.

The present library collection goes back to the days before the formation of Imperial Chemical Industries, Ltd., the nucleus being provided by the libraries maintained by Levinstein, Ltd., of Blackley, and British Dyes, Ltd., of Huddersfield; the bulk of the latter forms the nucleus of the branch library now maintained at Huddersfield, just as that of Scottish Dyes, Ltd., later formed the nucleus of the Works Library at Grangemouth, Stirlingshire. In 1925 the Levinstein collection was moved into the block of buildings which now houses the administrative offices of the Dyestuffs Division, being transferred in 1932 to a new wing specially designed to be permanent quarters. This was evacuated on the outbreak of war in 1939 and, after two years in makeshift premises in a local school, the Library was moved into a temporary single-story building adjacent to the Research Department of the Division. The library organization includes a Records and Reports Section which is responsible for the care of most of the Dyestuffs Division's permanent technical and commercial records and reports, of which about a hundred and fifty thousand different documents are at present filed; a Technical Section, which collects and indexes technical data of various kinds; and a Commercial Library, not housed in the new block, but situated adjacent to the Sales Departments in Hexagon House, which also collects commercial data.

The new library building, which connects two existing research blocks, has four main floors and a top floor that is occupied by a lecture theatre seating 156, most of the seats being provided with writing flaps. Of the total floor area of 17,000 sq. ft., 2,500 sq. ft. is occupied by the lecture theatre and ancillary rooms, 3,000 sq. ft. by the ventilating plant, corridors, lift, etc., and 2,000 sq. ft. by the basement store. The Main, Technical and Patents Libraries and library offices occupy 5,500 sq. ft., the Records and Reports Section 1,600 sq. ft., and general administration and workshop 1,200 sq. ft. All are characterized by light and spaciousness; the Main Library, on the first floor, measuring 75 ft. by 45 ft., has good north and south lighting and seating accommodation for forty. Shelving and reading space are arranged in the form of alcoves, and shelving and furniture are in walnut, many of the individual tables provided having built-in table easels.

The Technical Library on the ground floor has about one-third the area of the Main Library, and seating accommodation for twelve. It is equipped with cream-coloured steel adjustable shelving, and tables and chairs in natural oak. Adjacent to it is a workshop equipped for repair work on books and pamphlets, cover and case making, report binding and parcelling, and a small dark room off the work-

shop is equipped with photocopying apparatus. Off the Main Library, on the first floor, there is a small room for storing and reading microfilms. On the second floor there are the main files of the Records and Reports Section, the index room and the collection of British and foreign patent specifications.

ENERGY VALUE OF FOOD

TO determine the number of calories that a known weight of food will give when it is burned in a bomb calorimeter is relatively simple; but to assess accurately the number of calories that the animal body can derive from that food presents several problems which have not yet been satisfactorily solved. The subject was discussed at a symposium arranged by the Scottish Group of the Nutrition Society and held at the Hannah Dairy Research Institute, Kirkhill, Ayr, on April 30. The morning session was devoted to methods of assessing the energy of feeding-stuffs for animals, and the afternoon session to the problem as it concerns food for man. At intervals during the day some of the work in progress at the Hannah Institute on the production and emission of heat by farm animals was demonstrated.

In introducing the subject the chairman, Prof. R. C. Garry (University of Glasgow), stressed the danger of regarding food simply as though it were fuel for a machine. Food is much more than fuel, and the animal body much more than a machine. Food has to build, repair and maintain the fabric of the body as well as supply it with energy for work, and the body, unlike the machine, processes its fuel in digestion, absorption and metabolism. The content of minerals, vitamins and other substances present may all affect the energy value of the food by influencing the well-being of the animal, and in man the matter is still more complicated since social habit, beliefs and prejudices may all play a part. The chemistry of a foodstuff must be thoroughly understood: in time the biochemical processes by which energy is liberated from it will be elucidated; but it will still be essential to consider the living animal as a biological entity.

The first paper of the morning session was a joint communication by K. L. Blaxter and N. McC. Graham, who first dealt briefly with the history of methods of evaluating foods as sources of energy for livestock. They pointed out that reliable values are needed for planning livestock production both at farm and at national level, since on such values depend in large measure the animal product output of farming as a whole and estimations of the quantities of feeding-stuffs that must be imported. The second point they made was that measures of the energy value of foods are biological measures and cannot be expected to have the precision usually associated with the physical term 'calories' in which they are presented. Their statement that the efficiency of an animal in utilizing its food necessarily influences the nutritive value of the food it consumes emphasized this point, and was a theme that recurred time and again during the subsequent discussions.

Referring to the different ways in which the energy value of food for cattle is expressed, Blaxter and Graham emphasized the fact that, in order to estimate the value in terms of body storage of energy or in terms of energy transference to milk or eggs or its utilization for work, it is necessary to take into account the heat production incidental to the consumption of the food. For this reason the term 'net energy' or 'starch equivalent', as it is termed in Britain, which takes this heat production into account, is superior to expressions of energy value in terms of 'digested energy' or 'metabolizable energy'. Methods of determining net energy were then considered, and slides were shown illustrating the various types of respiration calorimeter in use in different parts of the world. The difficulties involved in interpreting the older calorimetric observations made with cattle and sheep, and indeed those at present being made by Blaxter and Graham at the Hannah Institute, were then considered. The effect of plane of nutrition and the type of basal ration used was discussed, and the fact that very small analytical and instrumental errors become greatly magnified by the very nature of the differential methods of computing the results was emphasized. Blaxter and Graham showed that, though well-known text-books and feeding-stuff tables quote energy values of some 250–300 foods, sixty years of work at Möckern experimental station in Germany, where almost all this work has been done, deal with but thirty-seven foods in seventy-one experiments. Most of the values in the tables are therefore computed values, and recent work has shown that the accuracy of these estimations is frequently very low. Finally, Blaxter and Graham deplored the tendency of workers in this field during the past fifty years—admittedly with a few exceptions—to become involved in many points of minor importance and to spend much time on what is nothing more than arithmetical re-expression of the results obtained by Kühn, Kellner and Armsby without contributing in any way to a deeper knowledge of the subject. They regard it as imperative that an end should be put to recalculating Kellner's results of 1900–5 and that emphasis should be placed on new experiments carried out in the light of modern knowledge of intermediary metabolism and with modern equipment.

The discussion was continued in a second paper by Dr. J. C. D. Hutchinson (Poultry Research Centre, Edinburgh), who dealt with the reasons why there has been so little progress in assessing the energy value of feeding-stuffs in spite of the great scientific, economic and practical importance of the subject. He referred to the great difficulties involved and the slowness of this type of work, and cited experience with the Danish calorimeter for cattle with which he is personally acquainted, where the output over a long period averages one result per worker per year. Dr. Hutchinson referred to some ways in which a greater output could be obtained—by adopting more automatic methods of measuring heat loss, by dispensing with the necessity of simultaneous estimates of carbon, nitrogen and energy retention and possibly by using methods involving carcase analysis or body-water determinations. He agreed with Blaxter and Graham that a more fundamental approach with less of the empiricism that has necessarily characterized the earlier work would prove most profitable in the future.

In the afternoon session Dr. E. M. Widdowson (University of Cambridge) mentioned that, until the Second World War, the energy values of food for man appeared to be of interest chiefly to compilers of food composition tables; but early in the War it was found that calorie calculations made on the two sides of the Atlantic did not agree, and this led to a better realization of the great practical importance of the subject. Dr. Widdowson discussed several tables of food composition published during the past fifty

years and stressed that, although the methods of computation vary considerably for different tables, none of them appears to be correct. All are based on work done half a century ago in Germany by Rubner and in the United States by Atwater, who had been a pupil of Rubner. Both these early pioneers measured the intakes of protein, fat, carbohydrate and calories of people on different diets and estimated the calories lost in the fæces and urine. From their results they calculated the energy values of individual foods and of mixed diets. In 1899 Atwater and Bryant concluded that protein and carbohydrate each give 4·0 kcal./gm. of total nutrients, and fat 8·9 kcal./gm.; and yet a few years later when they compiled tables of food values for the composition of several thousand foodstuffs, they used Rubner's earlier figures of 4·1 for protein and carbohydrate and 9·3 for fat—a strange inconsistency which they did not explain and which was the forerunner of many others by later compilers of food tables. Indeed, throughout the years as one error was corrected another appeared to creep in. Even as recently as 1947 the committee on calorie conversion factors and food composition tables of the United Nations Food and Agriculture Organization, in calculating the calories per gram of ingested protein, failed to apply properly a simple correction factor for the amount of unoxidized material excreted in the urine, and thus, while improving some portions of the general computation, introduced a new error in another portion.

Towards the end of her paper Dr. Widdowson dwelt on the great need for further experiments with mixed diets more typical of those eaten to-day than were the diets studied by Atwater. She also stressed the need for experiments to be done with larger numbers of people so that more information can be obtained regarding the sort of variation that normally exists between individuals in the number of calories they obtain from their food. She referred briefly to the need for evolving methods by which the physiological energy value of food in infancy and during growth can be assessed. She readily admitted that many mistakes have been made in computing the energy values of human foods; but endeavoured to console herself and those present by recalling that he who makes no mistakes rarely makes anything—certainly not food tables.

The second paper of the afternoon session was given by Miss D. F. Hollingsworth (Ministry of Agriculture, Fisheries and Food), who carried the general problem to its next stage by discussing the difficulties which are encountered in interpreting tables of food composition and in using them to estimate the energy value of human diets. For example, before the energy values given in tables can be applied in practice it is essential to consider how much of the purchased food is edible, how much water it contains, how much is lost in cooking and serving, and, as Miss M. Andross pointed out later in the discussion, how much is left as waste on the plate. To take one example, the moisture content of flour in food tables is usually assumed to be 12 per cent whereas in Britain for other purposes it is more normally taken as 15 per cent; this leads to a difference of roughly 3 per cent in the calculated energy value of the flour. Again, the fat content of meat can vary over a very wide range, and this can have a marked effect on the energy value computed for it. With made-up dishes the problems become still more involved, and in estimating requirements at an international level further complications arise when figures, which have been computed for British food supplies, are used for estimating the requirements of other countries where higher proportions of the total energy of the diet may be supplied by carbohydrates.

The four papers and the subsequent discussion achieved what was no doubt one of the main objects of the symposium, namely, to bring out some of the numerous difficulties that arise when attempts are made to assess accurately the energy values of foods, and to indicate some of the numerous problems that still wait to be solved by chemist, biochemist, physiologist and dietitian, as well as by those whose difficult duty it is to consider the general subject of world food supplies, their economics and distribution.

J. A. B. Smith

CHEMICAL ASPECTS OF SEMICONDUCTORS

A HALF-DAY symposium on "Chemical Aspects of Semiconductors" was held in the Chemistry Department of the University of Reading on March 26. The meeting, which attracted a gathering of some two hundred, was arranged by Dr. P. F. Holt (Reading) on behalf of the London Section of the Royal Institute of Chemistry. The chair was taken by Dr. F. S. Stone (Bristol). The aim of the symposium was to bring to the attention of chemists some of the problems of a chemical nature arising in the semiconductor field. The rapid developments in the technology of semiconducting materials which have taken place during the past ten years have only been achieved by close co-operation between the chemist and the physicist, and it is important that from time to time the current chemical problems in this predominantly physical field should be presented in a chemical forum. There is, moreover, a growing awareness among chemists of the contribution which semiconductors can make to fundamental studies on essentially chemical problems, such as adsorption and chemical bonding in solids, and this factor no doubt added to the general interest which the meeting aroused.

Since many of those present were not specialists in the semiconductor field, the main contributions were preceded by some introductory remarks on semiconductors, given by Dr. F. S. Stone. After outlining the principles underlying intrinsic and impurity semiconductivity, Dr. Stone dealt briefly with the rectifying and transistor action of germanium. In reviewing the chemical aspects, he stressed the importance of purification and standardization of materials. The significance of adsorption of active gases and vapours in creating a space charge at semiconductor surfaces was also emphasized, and attention was directed to the fact that very little fundamental work has so far appeared on adsorption at silicon and germanium surfaces.

The first of the more specialized papers was read by Mr. I. M. Ross (Services Electronics Research Laboratory, Baldock), who reviewed work on intermetallic semiconductors. Useful as silicon and germanium are for crystal-valve applications, their characteristics in respect of the combination of carrier mobility and separation between the valence and conduction bands are not entirely satisfactory. For other applications, such as photo-devices, quite different characteristics may be required. Interest has therefore turned to the closest analogues of

silicon and germanium, namely, compounds between elements in Group III and Group V (for example, InSb, GaAs) crystallizing in the zinc blende structure. Like the purely covalent germanium and silicon, the bonds in these 'III/V compounds' are also mainly homopolar. Mr. Ross pointed out that the band-separation in these compounds covers a wide range of values and that electron mobilities are in general high. With InSb, for example, which has been the most widely studied of these compounds, the electron mobility is 65,000 cm.²/volt-sec. at 300° K., compared with 3,600 cm.²/volt-sec. for germanium. The band-separation in this case is too low for transistor action at room temperature, but the high mobility has led to a number of new applications, particularly concerned with the Hall effect, in which the available power is some three hundred times that given by germanium. Mr. Ross demonstrated this to the meeting by showing the effect of the earth's magnetic field upon the current flowing in a crystal of InSb. He also outlined some of the technical problems associated with producing crystals of III/V compounds. Zone-refining (see below) is in general difficult to apply to these compounds due to their tendency to decompose, and, with the exception of InSb, the problems of purification and growth of single crystals have not been satisfactorily solved. In GaAs, for example, reliance has had to be placed on extensive purification of the parent elements. A further problem, the study of which has only just begun, is that of obtaining stoichiometry in these compounds.

A contribution which aroused much interest was made by Mr. A. A. Smales (Atomic Energy Research Establishment, Harwell), who reviewed methods for estimating trace impurities. Besides sensitivity, specificity and accuracy, Mr. Smales classified the various methods according to their advantages in respect of freedom from contamination (either adventitious or from reagents) and their ability to deal with several elements simultaneously. Emission spectroscopy has this latter advantage and is highly specific. Freedom from contamination may be avoided if the material is examined directly, but not if impurities have been chemically concentrated before determination, to enhance the sensitivity. The most sensitive methods are undoubtedly the isotope dilution technique, employing mass-spectrometric analysis, although the contamination problem still exists there, and the radioactivation method, which involves neutron irradiation in a pile followed by radiochemical separation. For many elements these methods have sensitivities better than 1 part in 10^9. The first technique is applicable only to those elements for which separated isotopes are available, while the second is limited to those with suitable nuclear characteristics; nevertheless, more than half the elements can be determined by one or the other method. Both require that elements be analysed individually, though the development of gamma-ray spectrometers will ultimately enable the radio-activation technique to be more versatile in this respect. Using the vacuum-spark ion source, the mass spectrometer may be applied to the determination of several elements simultaneously, but the sensitivity is greatly reduced. Mr. Smales also described the more conventional methods, such as colorimetry and polarography, pointing out that although they are fairly sensitive (0·1–1 p.p.m.), the reagent blank problem remains a major limitation.

Mr. H. J. Cluley (General Electric Co., Ltd., Wembley) described chemical processes for obtaining germanium and silicon in high purity. Germanium is extracted as the tetrachloride from coal (flue dusts) or from zinc blende during smelting. Purification is then effected by fractional distillation and refluxing over copper or by repeated distillation. Arsenic, the main impurity, is thereby reduced in concentration to less than 1 part in 10 million. The metal is obtained by hydrolysis to germanium oxide and reduction with hydrogen. High-purity silicon may be prepared by fractionation of silicon tetraiodide, followed by the van Arkel technique of thermal decomposition at a hot filament. A second method is the reduction of silicon tetrachloride with zinc in the vapour phase. Mr. Cluley also reviewed other methods involving the thermal decomposition or hydrogen reduction of silicon compounds. Before germanium and silicon can be used for electrical work, further purification by zone-refining is necessary. The details of this technique were described by Mr. S. E. Bradshaw (General Electric Co., Ltd., Wembley). In zone-refining, a molten zone is slowly but repeatedly made to pass along an ingot of the material. The effect is to concentrate the impurity at one end since, when an impure solid is melted, the impurity concentration in the solid (c_s) differs from that in the melt (c_L) with which it is in equilibrium. If the segregation coefficient K ($K = c_s/c_L$) is less than unity, the impurity is swept in the direction of traverse. If K is greater than unity, the impurity concentrates in the regions where freezing begins. Unless K happens to be close to unity (for example, boron in silicon), the method is extremely effective and impurity concentrations can readily be reduced to 1 part in 10^8.

A paper by Mr. J. I. Carasso (Post Office Research Station, Dollis Hill) dealt with two chemical factors affecting the performance of germanium diodes. The first of these was the use of nickel as an additive for the controlled shortening of carrier life-times, a requirement for high-frequency operation. It is found that the addition of nickel to the melt during the crystal-growing stage does not produce the required degree of control, the resulting concentrations of nickel in germanium being different from those expected on the basis of a simple treatment of the segregation coefficient. This anomaly is explained by a suggested diffusion of nickel atoms through the germanium lattice. Direct addition of nickel to germanium by lattice diffusion from a nickel/germanium interface may, in fact, be a more satisfactory method of controlling the incorporation, and Mr. Carasso described experiments of this type at present in progress at Dollis Hill. The second topic treated by Mr. Carasso was surface contamination. Adsorbed gas may exert an influence upon a p–n junction due to surface mobility of charged particles. Or again, the space charge arising at the surface may itself be sufficiently intense to form, for example, a p-type 'skin' on n-type material (channel effect). Thirdly, opportunity is provided for high rates of carrier recombination at the surface. Mr. Carasso discussed specifically the behaviour of water vapour and iodine vapour, showing that the channel effect for water is opposite to that for iodine.

The importance of employing single crystals of a high degree of perfection for semiconductor work is frequently emphasized. This aspect of the field was covered by Dr. E. Billig (Associated Electrical Industries, Ltd., Aldermaston), who gave a descriptive account of the methods of growing single crystals. Among other points, he discussed the correlation of heat dissipation with growth-rate and mentioned

that the usual rates, as obtained by the standard Kyropoulos method, could be considerably increased by undercooling the melt. Melts can be undercooled by as much as 20–30° C. without risk of nucleation. Dr. Billig showed that if one (111) plane of a germanium crystal is maintained vertical, the crystal is able to grow without the need for nucleating new layers; no experimental evidence of growth from spiral dislocations has in fact been obtained in this work. Imperfections, however, do arise, due possibly to the occlusion of impurities and to mechanical stresses. Such stresses are commonly caused by uneven temperature distribution or by certain crystallographic features such as the intersection of two twin boundaries. A single twin boundary, on the other hand, apparently has no effect on the electrical properties. Dr. Billig concluded by showing a film illustrating various features in the growth of germanium and silicon monocrystals. Under certain conditions, such crystals have been obtained in the form of thin plates which display a striking degree of external symmetry. The film also showed the extremely rapid growth of dendritic crystals in the form of thin and long lamellæ, demonstrating in a convincing manner that, even in an isotropic medium of cubic symmetry, crystal growth can take place by the deposition of individual layers orientated along the close-packed (111) planes. F. S. STONE

STAR-STREAMING FROM STARS OF SPECTRAL TYPES *A* AND *B*

A PAPER by T. R. Tannahill on "Star-Streaming from the Stars of Spectral Type *B*" (*Mon. Not. Roy. Astro. Soc.*, **114**, No. 4; 1954) gives the results of his analysis, on Eddington's two-drift hypothesis, of the proper motions of 1,536 stars of spectral types *O* and *B* in the Boss "General Catalogue". The material for the investigation was grouped into ten regions, each region consisting of a 'square' of north galactic latitude combined with the diametrically opposite region of south galactic latitude, as shown in the first table of the paper. An examination of this table and also of the drift-curves establishes that it is impossible to represent the motions of the *B*-type stars by a single drift, and a large proportion of the stars has been assigned to a second drift in order to make a satisfactory fit; in four out of the ten regions in Drift ii the number of stars exceeds that in Drift i. From an analysis of the data, the drift constants are derived with the probable errors.

In a previous paper (*Mon. Not. Roy. Astro. Soc.*, **112**, No. 3; 1952), Tannahill gave the corresponding results from the galactic zone of stars of types A_5–*M*, and a comparison with the present results indicates satisfactory accordance, considering the probable errors involved. The values of *L*, *B* and *hW*, the galactic co-ordinates of each drift apex and the space velocities of each drift, are used to calculate the theoretical values of hV_c and θ_c—that is, the projections of the space-velocities of the drifts on the tangent-plane at the centre of the region, and the position angles of the directions towards the drift apices—and these are listed together with the residuals $hV_c - hV$ and $\theta_c - \theta$. Considering that only 1,536 stars were used in the investigation, the residuals are quite satisfactory except in Drift i, region 5, where $\theta_c - \theta_1$ exceeds 49°. The linear components of the motion of Drift i relative to Drift ii are given in a table, and also the galactic longitude and latitude of the vertex of star-streaming and the relative space-velocity of the drifts. One curious feature is the close agreement of the galactic co-ordinates of the vertex position (343·3°, −1·6°) obtained by the investigation, and that normally found (343°, −2°). It is admitted that the closeness of the agreement must be regarded as fortuitous, on account of the probable errors involved. Nevertheless, this does not vitiate the final conclusion, and the result "removes any shadow of doubt that the *B*-type stars exhibit the phenomenon of star-streaming".

The subject is continued in a further paper (*Mon. Not. Roy. Astro. Soc.*, **114**, No. 5; 1954), "Star-Streaming from the Proper Motions of the *A*-Type Stars of the Boss 'General Catalogue'", in which are given the results of the analysis of the motions of 8,676 stars of the spectral types B_8–A_3. The method of dealing with the data follows closely that described in the 1952 paper for stars of types A_5–*M*, and stars belonging to known clusters have been rejected; of these, twenty belong to the Pleiades group, forty-six to the Ursa Major group, and nine to the Taurid cluster. The same difficulty in analysis arose as with the A_5–*M* stars, the regions around Drift i apex offering certain problems in analysis, especially in the determination of the Drift ii constants. The higher concentration of the stars in the galactic plane, the regions in the higher galactic latitudes being sparsely populated, presented further difficulties; but in spite of these, analysis was possible in all regions, and the results are given in nine tables.

One rather surprising feature may be mentioned: in the A_5–*M* types there was a marked decrease of *hW* with advancing spectral type, which was not maintained in the *A*-stars. There was a decided systematic change in the Drift ii apex, the right ascension decreasing, and the declination increasing, with advancing type. In addition, large and apparently irregular variations occurred in some of the quantities determined, and, judging by the probable errors involved, must have a statistical significance, yet they indicated no systematic trend. Some possible reasons for these discrepancies are suggested by Tannahill, and though they are only tentative, it is probable that future research will modify some of the hypotheses on which present investigations are based. The galactic co-ordinates of the vertex were found to be (365·5°, −0·5°), and the equatorial co-ordinates of the solar apex (264·8°, +31·5°); the latter is not far from the co-ordinates of the solar apex as found from the streaming of the spectral type *B* stars (260·7° + 37·3°).

THE INSTITUTE OF SEAWEED RESEARCH

IN the annual report for 1954 of the Institute of Seaweed Research, the interested layman's attention will be attracted by the statement that "mechanical harvesting of sublittoral Laminariaceae has now been proved to be a feasible and reasonably cheap operation". At present, six seaweed-processing factories in Scotland use more than 30,000 tons of cast weed annually, and it is estimated that one motor fishing vessel adapted to operate twin I.S.R. belt harvesters should be able to collect more than five thousand tons of *Laminaria cloustoni* a year in good areas. One of the main objectives of the Institute

has therefore been attained and the advantage to the seaweed industry of planned collection of the material over cast weed is obvious.

If mechanical harvesting has been the limiting factor in the industry up to the present, its adoption may bring fresh problems. If it becomes regular practice, limited in the main by the state of the weather and sea only—it is suggested that harvesting on at least 170 days a year is a reasonable assumption—it becomes important to assess the effects of harvesting on the density of the beds of *Laminaria cloustoni* as well as on the associated fauna and flora. The same report indicates that changes in the density of these beds occur from year to year when they are subject to natural conditions only, and hence it is reasonable to ask what effect harvesting will have on them.

Processes for the manufacture of mannitol, aminarin, calcium alginate and fucosterol have been perfected at the Institute; but whatever products are to be made use of commercially, the industry is in the last resort dependent on a continuing supply of the plant. Experimental work on the effect of harvesting is therefore of prime importance.

Kathleen M. Drew

WORK STUDY

In one of the occasional papers published by the Institute of Personnel Management, a useful corrective is given to the unfortunate trend in industry which regards work study as the panacea for all industrial ills. Valuable as they are, work study and monetary incentive schemes are techniques which can have the most harmful consequences; they may increase production in the short run (not always in the long run) but at a social and psychological cost which is no less serious because it cannot be immediately perceived. It may be argued that it is unjustifiable to criticize work study together with the use of narrowly conceived incentive schemes, on the ground that there is no necessary connexion between them. There is, of course, no necessary connexion, but, in practice, there has developed a very natural connexion: the increase in repetitive work and the progressive simplification of the job have required that a substitute incentive be found for the satisfaction and skill so often destroyed. Among the many dangers and disadvantages of direct incentive schemes the following seem to be among the most important.

They are sought and used as a substitute for managerial skill in other directions, and they tend to deflect attention from matters which should have a far higher degree of priority in the development of any management policy; for example, production planning and sales/production co-ordination, education and training, method study, and systems of cost control.

The foreman's direct responsibility for output is reduced; this is said to be an advantage in that he is thus enabled to carry out more important duties. In fact, the stresses impinging on the foreman are frequently increased by the introduction of an incentive scheme and become more frustrating and harmful in character.

The impact of incentive earnings on the wages structure can be very detrimental and lead to much discontent. Supervisory differentials and other evaluated jobs are adversely affected by distorted earnings in other departments.

The installation of an individual incentive scheme frequently has a disintegrating effect on the working group which in many cases is resolved by tacit agreement among workers to restrict output to an agreed level; this is strongly condemned by management, who fail to understand that in the circumstances it is indispensable for the social equilibrium of the group.

As the whole emphasis of the incentive scheme is on producing the maximum individual reward, the effect is for the incentive bonus to be won regardless of necessary co-operation with supervisors and fellow-workers. The quality of production frequently suffers despite careful inspection procedures.

The scientific accuracy of time study has yet to be demonstrated, and the trade unions, aware of the difference in standards between time-study men, are not slow to take advantage of these opportunities in negotiation; in this respect time study may be regarded as a tool for collective bargaining.

Not the least important is the insidious effect that incentive schemes can have on the moral qualities and sense of responsibility of the individual. It is perhaps to be expected that a system which attempts to allocate a precisely defined reward for every action of the individual in his working society should have its repercussions elsewhere.

CONGENITAL PORPHYRIA IN SWINE AND CATTLE IN DENMARK

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Congenital porphyria is a rare inborn error of metabolism in man and animals. It is occasionally seen in pigs and cattle in slaughter-houses because of the reddish-brown colour of the bones and teeth; but it has only once been studied in live cattle[1] and live pigs[2]. For further information the reader is referred to the survey by Rimington[3]. It is a puzzling coincidence that congenital porphyria has been found in both pigs and cattle in Thisted County in North Jutland. We are now studying the live animals.

In October 1951 one of us (S. K. J.) found dark bones in pigs at Thisted slaughter-house. This reduced the market value of the pork, and in consequence an investigation was started. The condition could be diagnosed with reasonable certainty on inspection of the colour of the teeth in the newborn pigs; pigs with dark teeth as a rule develop porphyria. After elimination of all pigs with dark teeth, the condition disappeared; since February 1954 no new cases have occurred at Thisted. Two sows with porphyria were transferred to the State Experiment Farm of Faurholm for breeding studies and chemical investigations under the direction of Prof. H. Clausen and a senior experiment officer, N. J. Højgaard Olsen, in collaboration with one of us (T. W.). Some material was also sent to Prof. C. Rimington in London.

The best method of characterizing the severity of porphyria in a pig is quantitative analysis of the

teeth or bones for porphyrin; for example, the teeth of new-born pigs. The analysis is carried out as follows (to be published by T. K. W.[3a]): The small teeth are treated with 0·5 *N* hydrochloric acid, which extracts the porphyrin but not the other dark pigments present; the porphyrin is determined spectrophotometrically in the extract by the method of Rimington and collaborators[4]. Bones are pulverized with a file, about 50 mgm. of the powder is weighed out and shaken for about a minute with 5 ml. of 0·5 *N* hydrochloric acid; after standing for an hour, centrifugation is carried out and then the determination is made.

The distribution of porphyrin within the skeleton varies considerably. In the compact substance, the concentration is often five to ten times as high as in the spongy tissue; and even within the former, certain zones may contain considerably more than others—a fact readily seen on direct examination of the bones in Wood's light. The porphyrin of the teeth is for the main part located in the dentine; the enamel contains at the most only traces of porphyrin. Teeth of new-born pigs with porphyria contain a dark non-porphyrin pigment besides porphyrin, and this is not extracted with dilute hydrochloric acid. Most often dark teeth show definite fluorescence in Wood's light; but occasionally they may fail to do so, and in such cases the extract with 0·5 *N* hydrochloric acid as a rule shows a beautiful red fluorescence. Consequently, a tooth from a new-born pig cannot be regarded as porphyrin-free because it fails to fluoresce in Wood's light. Extraction with dilute hydrochloric acid and examination of the fluorescence of the extract is required.

Teeth of new-born pigs contained from a few μgm. porphyrin per gm. in slightly affected animals to 200 μgm. per gm. in severe cases; in the bones of adult pigs, figures of the same order were found. Lutidine chromatography[5] showed that the porphyrins of the bones and teeth were mainly uroporphyrins, with minor amounts of coproporphyrins. The most severely affected pigs excreted 1,000–10,000 μgm. of uroporphyrin in the urine per 24 hr., the more slightly affected only 100–750 μgm. Besides the uroporphyrin, smaller amounts of coproporphyrin were excreted (about 50 μgm. per 24 hr.). No porphobilinogen was found in the urine. Lutidine chromatography[5] on the urinary porphyrins showed the presence of small amounts of porphyrins with three, five, six and seven carboxyl groups besides the 8-carboxyls (uroporphyrin) and 4-carboxyls (coproporphyrin). Dioxane chromatography[6] showed that about 70 per cent of the uroporphyrin in urine and bones was uroporphyrin I, about 30 per cent uroporphyrin III. Paper chromatography of the coproporphyrins[7] showed that the main part was coproporphyrin III.

The health of pigs showing porphyria was very little if at all affected, except in the most extreme cases. Photosensitivity of the skin was never observed. A single boar died spontaneously showing symptoms of heart failure, which may have been due to porphyria. The heredity of the condition is not quite clear; but our observations point towards a single dominant gene, although a more complicated mechanism cannot be excluded.

In cattle, congenital porphyria has turned up occasionally in Thisted County for at least twenty years in animals of the Shorthorn breed. In 1952, a farmer complained of one of his young cows, that it was not getting on at pasture but did well in the stable. It was sent to the slaughter-house and found to have dark teeth and bones. One of us (S. K. J.) examined the bones; but they have since been lost except for a tooth which on analysis showed 239 μgm. uroporphyrin per gm. In November 1954, a young bullock with discoloured teeth was found on a veterinary inspection of livestock. This bullock and its dam were sent to Svendborg for chemical study. The cow was found to be free from porphyria whereas the bullock excreted large amounts of porphyrins with urine and fæces, although it was in excellent health and development. A tooth was extracted and showed 77 μgm. uroporphyrin per gm. This tooth was sent to Prof. Rimington in London. The tip of its horn was sawn off, and the tip of the bony core removed showed bright red fluorescence in Wood's light.

The bullock excreted with its 24-hr. urine about 100 mgm. of porphyrin, consisting of about 30 per cent coproporphyrin and about 70 per cent uroporphyrin. The percentage of the total porphyrins consisting of coproporphyrin varied considerably from one portion of urine to the other, the extreme values being 5 and 60 per cent. No uroporphyrin chromogen[7] was found and only 10 per cent or less of the coproporphyrin was excreted as chromogen. Porphobilinogen was present in amounts of 25–50 mgm. per 24 hr. This was demonstrated by a positive Ehrlich reaction, the dye of which was not extracted with chloroform, and it was measured quantitatively as uroporphyrin[8] after boiling at *p*H 5–5·5[4]. This occurrence of porphobilinogen is, if confirmed, rather remarkable, because this compound has not been found in congenital porphyria before. The porphobilinogen excretion was not constant, but intermittent. We have not so far succeeded in isolating the porphobilinogen in a crystalline condition; but we obtained once a purified and concentrated solution by means of Westall's[9] procedure.

The fæces of the bull contained, per gm. of dry substance, 100–250 μgm. of coproporphyrin (extracted from ether with 0·1 *N* hydrochloric acid), 10–25 μgm. of dicarboxyl (proto) porphyrin (extracted from ether with 5 per cent hydrochloric acid), and 50–100 μgm. of the uro-type (ether-insoluble). The latter showed an absorption maximum at 402 mμ in 0·5 *N* hydrothloric acid and is therefore probably not uroporphyrin. The corresponding figures for normal cows in the same stable and on the same feed were respectively 1·0, 3–5 and nil.

Finally, it may be mentioned that a young bull with porphyria was slaughtered at Thisted in January 1955. Its bone contained 94 μgm. uroporphyrin per gm. of the compact substance of the lower jaw; the spongy substance contained only 13–32 μgm. per gm. and a tooth 21 μgm. per gm. After this, a thorough analysis of the cattle of Thisted County based on analyses of fæces and teeth from all animals in stocks where cases have occurred was planned and is now going on. Our studies on the heredity of the condition have so far supported the view of Fourie[1] that congenital porphyria in cattle is inherited as a recessive character—contrary to congenital porphyria in pigs, which is inherited as a dominant character.

In conclusion, we wish to point out that the considerable quantities of porphyrins excreted per 24 hr. by our bullock—200 mgm. coproporphyrin with the fæces, and about 35 mgm. with the urine as well as about 65 mgm. uroporphyrin with the urine—are easily extracted and purified.

Since the bullock is a young and healthy animal, it can be expected to yield large amounts of porphyrin for several years, some of which may be made available as marker substances for paper chromatography and delivered to laboratories concerned with porphyrin analysis. Investigators who may be interested in obtaining porphyrin markers are invited to communicate with us (T. W.) concerning this question.

We wish to thank Prof. C. Rimington, University College, London, for valuable advice and never-failing interest, and the Sales Association of the Danish Export Bacon Factories (Eksport-Svineslagteriernes Salgsforening) and the Co-operative Danish Cattle-breeding Associations (De Samvirkende Kvægavlsforeninger) for financial support.

[March 3

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STEREOCHEMICAL STRUCTURE OF CYTOCHROME *c*

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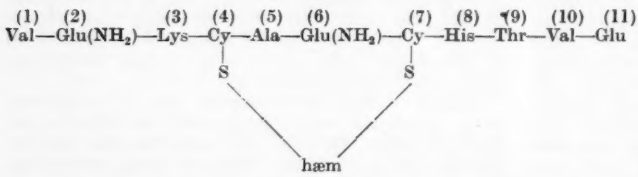
RECENTLY, a hæmopeptide obtained by peptic degradation of cytochrome *c* has been purified and its structure determined[1]:



Its physico-chemical properties in the ferric state have been examined in some detail[2] and compared with those of cytochrome *c*[3]. Magnetic measurements revealed that the bonds to the iron were essentially ionic in acid solution, but octahedral d^2sp^3 bonds at alkaline reaction. On acidification, the covalent bonds to the hæmochromogen-forming groups are released stepwise, with spectrophotometrically operable *pK*'s of 5·8 and 3·4 respectively; that titrated at *p*H 3·4 is presumably the imidazole residue of histidine (8), while the other one is either the α-amino group of valine (1) or the ε-amino group of lysine (3)[2].

With the aid of a set of steric bond models for building peptide chains with coplanar peptide bonds (generously given to us by Prof. L. Pauling), we have investigated different sterical possibilities for the hæmopeptide. For that purpose a hæm model in the same scale (1 A. = 1 in.) was made from a metal disk, and the side chains involved were manufactured from bent metal rods and suitable joints allowing free rotation around the axis of the bonds.

It was assumed that all the amino-acids had the l-configuration. The peptide-chain model was folded to correspond to the various left- and right-handed helix-structures described[4]: α-helix with 3·7 amino-acid residues per turn, π-helix with 4·4, and γ-helix with 5·1. Then attempts were made to connect the two cysteine side chains of the peptide with the α-carbon atoms of the vinyl groups in positions 2 and 4 of the hæm disk (two possibilities) and one or two hæmochromogen-forming groups with the iron.

The γ-helix structure could immediately be excluded because of strong steric hindrance. With the α- or π-helices, the thioether bonds could always be formed. In these cases the ε-amino group of lysine (3) could be attached to the iron; but it was never possible with the α-amino group of valine (1).

Interest was, however, focused on the imidazole imino group of histidine (8), since there is good evidence to show that two such groups are hæm-linked in cytochrome *c*. With the π-helix this group could reach the iron only with strain, and the angle between the helix axes and the hæm disk became about 70°. Both the left- and right-handed α-spirals with the cysteine (4) connected to the side chain 4 of the hæm disk gave rigid but strainless structures with the helix axes very nearly parallel to both the hæm plane and the imidazole plane. Since only the left-handed α-helix has been demonstrated in Nature, we believe this structure to be the most probable one. The α-helix of the hæmopeptide occupies just one-quarter of the space around the hæm. In cytochrome *c* at about neutral *p*H it is thus plausible to imagine four such helices arranged symmetrically about the hæm disk, thus shielding it from direct contact with, for example, oxygen, carbon monoxide or cyanide, but, nevertheless, in some way allowing electrons to be exchanged.

The alternatives of 'pleated sheet' configurations in cytochrome *c* looked very improbable for steric reasons.

In the hæmopeptide, two of the available hæmochromogen-forming groups could reach the iron simultaneously only if the structure was unfolded to a large extent.

At a low *p*H, no stable links can be formed between the molecules, and the hæmopeptide is no doubt monomer. At higher *p*H, covalent bonds to the iron might be formed both intra- and inter-molecularly. The fact that the hæmopeptide is precipitated between *p*H 4·4 and 7·1 may be due to a combined effect of such intermolecular bonds and the proximity of the isoelectric point (about *p*H 5). At an alkaline reaction the hæmopeptide is again soluble and hæmochromogen formation is complete[2]. In the case of the rigid α-helix structures it is not possible for both the iron-linked groups to be bound intramolecularly, and some kind of polymerization must take place. For steric reasons it would be expected that one or more types of polymers would be preferred. In the case of an unfolded structure, however, polymerization would be much less favoured and irregular.

In order to study the molecular weight of the hæmopeptide under different conditions, we have carried out some sedimentation experiments in a Spinco ultracentrifuge. We obtained sedimentation constants of 0·6 *S* at *p*H 2·3 and 1·6 *S* at *p*H 8·7. In both cases the hæmopeptide appeared to be almost monodisperse. The molecular weights could be estimated as 2,000 and 11,000 respectively, while the formula of the hæmopeptide corresponds to $M = 1880$. The existence of a monodisperse penta- or hexa-mer at alkaline reaction thus strongly supports the existence of a rigid helix structure.

Tuppy and Bodo[5] added increasing amounts of histidine at *p*H 7 to the reduced form of hæmopeptide obtained by tryptic digestion of cytochrome *c* and observed absorption bands approaching the extinction coefficients of ferrocytochrome *c*. By adding 0·14 *M* histidine to a solution of the peptic hæmopeptide at *p*H 8·7, we obtained a spectrum nearly identical with that of ferrocytochrome *c*. This suggested that the free histidine competitively replaced the bonds causing the polymerization. To test this possibility, an ultracentrifugal experiment was carried out under the same conditions and it showed that the sedimentation constant had in fact decreased from 1·6 *S* to 0·8 *S*. The depolymerization effected by histidine was probably incomplete, since the hæmopeptide appeared to be slightly polydisperse.

In order to illustrate further the hæmochromogen-forming capacity of the groups considered, a spectrophotometric study of ferri- or ferro-protohæm plus histidine, lysine or glycyl-glycine was made at *p*H 7. With lysine or glycyl-glycine, no reaction was observed. This was not unexpected, since the pK of primary amino-groups is between 8·5 and 10·5. Histidine, on the contrary, has a pK of 6·1, and two molecules of the histidine combined simultaneously with one molecule of the protohæm ($n = 2$). The dissociation constants for the histidine protohæm compounds were found to be $K_{ox} = 0{\cdot}004\ M^2$ and $K_{red} = 0{\cdot}015\ M^2$ at 20° C. Our result, $n = 2$, is in line with the findings of Cowgill and Clark[6], who studied the combination of several imidazoles with ferri-mesoporphyrin. The fact that $n = 2$ also in cytochrome *c* [7] cannot of itself be taken as an evidence that the iron-linked groups are identical. The present demonstration of the much higher ability of histidine to form a hæmochromogen at *p*H 7 as compared with other amino-acids must, however, be considered as strong support for the view that both the iron-linked groups of cytochrome *c* really are histidine imidazoles. Furthermore, Margoliash recently found that two of the four imidazoles in horse cytochrome *c* do not react with dinitrofluorobenzene[8].

It is interesting to notice that the isolation of a peptide fragment with eleven amino-acids, two or three of which are attached to a hæm molecule in a known way, has made it possible to make predictions concerning the sterical structure of the undegraded protein, without the aid of X-ray investigations.

A detailed report of this work will be presented in *Acta Chemica Scandinavica*. [March 30

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AGES OF PITCHBLENDES BY X-RAY DIFFRACTION

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In a recent communication in *Nature*[1], it was shown how uraninites, essentially $UO_{2\pm x}$, could be classified into three mineralogical types, and that two of these fitted into a scheme of age determination based on progressive shrinkage of the unit cell. The third type, β-uraninite, or better known as pitchblende, was discarded as unsuitable.

Further work on pitchblendes supports this general conclusion—with certain qualifications. Relatively young pitchblendes give slightly lower cube-edges, that is, higher ages, than normal; but older pitchblendes can be accommodated within the new scheme of age determination. The explanation for such results may be found in the varying poor crystallinity of the pitchblendes. Like glass, which devitrifies with time, the older samples seem more amenable to a method relying on crystallographic measurements. Defective crystal lattices can be expected to occur in material which often appears glassy or shows signs of a colloidal origin.

Even in a scheme of age determination by X-ray diffraction, pitchblendes, although scarcely qualifying as crystalline, could not be entirely ignored. Their X-ray spectra are unsatisfactory for measurement. Heating produces a sharper spectrum, and, as uranium oxide is known to be stable in hydrogen even above 1,000° C., it is argued that ignition in hydrogen of pitchblendes would remove their characteristic excess of oxygen to give the required α-type, the parameter of which serves as the criterion of age. From the classification data previously presented[1], it was predicted that this ignition would increase the parameters of pitchblendes, and this was, in fact, observed.

Locality	Before ignition	After ignition
Gilpin, Col.	5·42 A.	5·443 A.
Cornwall	5·40 ? A.	5·455 A.
Vizeu, Portugal	5·40 ? A.	5·443 A.
Joachimstal, Czechoslov. (several samples)	5·41 A.	5·435–5·448 A.
Pribram, Czechoslov.	5·41 A.	5·448 A.

The error in some determinations approached 0·01 A.; nevertheless, it is clear that ignition markedly increased the cube-edges; but they mostly fall short of the anticipated values around 5·46 A. (Other types of uraninites when heated *in vacuo* or in different atmospheres show a *decrease* in the cube-edge value.)

These results show that the transition from β- to α-type takes place as predicted. The value from the Cornwall sample, suggesting an age around 400 million years, may be correct within the experimental error; but the higher ages, that is, the lower cube-edge values, may be due to such crystal defects as vacant uranium atom positions, or replacements of uranium. In the Gilpin sample, such replacement by the small ions zirconium and titanium may well account for the abnormal reduction in cube-edge.

Turning to older pitchblendes—and the method primarily aims at establishing pre-Cambrian data—it became desirable to compare both an α-type and a pitchblende (that is, β-type) from the same deposit in the hope of cancelling out any major effects due to differences in age or composition. Only from one

locality were both types available for investigation, namely, from the Rhokana Mine, Kitwe, Northern Rhodesia. Differences in these two types cannot entirely be ruled out, but similar results would suggest that these differences were negligible. The results obtained were :

Rhokana Mine

Untreated pitchblende (that is, β-type)	5·417 ± 0·007 A.
After 1 hr. in hydrogen at 950° C.	5·443 ± 0·004 A.
Untreated α-uraninite	5·453 ± 0·003 A.
After 1 hr. in hydrogen at 950° C.	5·447 ± 0·003 A.

The agreement after heating is highly satisfactory. It is likely that minor alteration has increased the untreated α-type—this phenomenon is commonly encountered in γ-types (paper in preparation) when oxygen enters the crystal lattice interstitially.

The slightly lower value for the heated pitchblende sample when compared with the α-type is not unexpected in view of the previously mentioned findings. The value for the untreated α-type agrees with the 'chemical age' of 520 million years reported by Davidson[2], while the parameter obtained after heating is identical with that found for the Belgian Congo α-uraninite and therefore has an age of 620 m.y. The data at this stage are not sufficient to decide the issue ; but they clearly indicate this narrow range in ages.

The real significance of the Rhokana results is that they show the relationship between α- and β-types to be as presented in my classification, and thereby a procedure in obtaining ages from pitchblendes by X-ray diffraction is indicated.

With this background the method was applied to two relatively older pitchblendes the ages of which are more precisely known from isotope measurements —such material is difficult to find. Exceptionally, sufficient material was available for differential thermal analyses by Mr. E. R. Schmidt of this laboratory, and this investigation supported their classification as β-types.

(A) Madagascar

Through the kindness of one of the authors, Dr. H. Besairie, of a recent publication on the ages of radioactive minerals of Madagascar[3], I secured a duplicate specimen of the Bemasoandra uraninite, the lead isotopes of which, determined by Nier, gave the following results :

$^{208}Pb/^{207}Pb$	$^{208}Pb/U$	$^{207}Pb/U$	$^{208}Pb/Th$
480 ± 20	390	410 ± 4	465 ± 2

The real age taken by the authors from these data is 480 ± 15 million years.

The X-ray results were as follows :

Bemasoandra

Untreated pitchblende	5·444 ± 0·003 A.
After 1 hr. in hydrogen at 950° C.	5·459 ± 0·003 A.
After correcting for thoria	5·455 ± 0·003 A.

The parameter 5·455 A. becomes the criterion for age. As the shrinkage of the cube-edge with time is about 0·0035 A. per hundred million years, it follows that the Bemasoandra β-uraninite is just 200 million years younger than the well-authenticated age for Belgian Congo (see table), so that the X-ray results therefore give an age of 420 million years.

The experimental error is probably less than 100 million years, and the agreement with the age from isotopic data is as good as can be expected. This result is important in supporting the reasoning adopted in this investigation.

(B) Great Bear Lake

The age of the well-known pitchblende from this Canadian locality is now accepted as close to 1,400 million years[4]. Marble[5] has shown that thoria is absent and that the rare-earths are of minor significance ; in the α-uraninite derived from this pitchblende, only radiogenic lead will therefore affect the cube-edge.

This pitchblende differs from those of its group as it is the only one which showed a reduction in cube-edge after ignition in hydrogen. It is suggested that weathering increased its cube-edge due to the introduction of interstitial oxygen. The X-ray data found were as follows :

Great Bear Lake

Untreated pitchblende	5·453 ± 0·004 A.
After 1 hr. in hydrogen at 950° C.	5·421 ± 0·002 A.

These results were duplicated under slightly differing conditions ; the spectra obtained were very satisfactory and the chemistry of the material is well known—these factors suggest a high accuracy in determination. The parameter 5·421 A. indicates an age just over 300 million years greater than the well-established age for Wilberforce, Ontario. The X-ray data therefore give an age of 1,350 ± 50 million years.

The agreement with the age determined by means of isotope data can scarcely be bettered.

Considering the kind of material that pitchblendes represent, it is remarkable that one can recognize with the aid of X-rays such a degree of order in them. Their relationship to the better crystallized members of this mineral group now finds a satisfactory explanation, and their study completes the picture of the uraninites and their age determination by means of X-rays. By inserting the two newly found values for the two pitchblendes from Madagascar and Great Bear Lake in the previously published table, perfect fits are obtained which greatly strengthen the chain of results—almost halving the gap between 1,000 and 2,000 million years. The augmented table now reads :

Samples	Types	Isotope ages	Cube-edges (corrected for thoria)
Uranium oxide—artificial	α	Zero	5·470 A.
Connecticut, U.S.A.	α	250 m.y.	5·463 A.
Madagascar	β	480 ± 15 m.y.	5·455 A.
Belgian Congo	α	620 m.y.	5·448 A.
Bisundni, India	α	735 m.y.	5·443 A.
Gaya, India	γ	955 ± 40 m.y.	5·436 A.
Wilberforce, Canada	γ	1,035 m.y.	5·432 A.
Gordonia, S. Africa (Mountain)	α	1,025 m.y.	5·428 A.
Gordonia, S. Africa (Holmes)	γ	1,025 m.y.	5·427 A.
Great Bear Lake, Canada	β	1,400 m.y.	5·421 A.
Witwatersrand, S. Africa	γ	2,000 m.y.	5·400 A.

An interesting fact that can be read from the table is that the exploited deposits of the Belgian Congo, Great Bear Lake and the Witwatersrand yield, respectively, α-, β- and γ-uraninite. [Feb. 5

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LETTERS TO THE EDITORS

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Macromolecular Weight and Size of Deoxypentose Nucleic Acids

RECENT measurements of the weight of deoxypentose nucleic acid molecules extracted from calf thymus[1], pneumococcus-transforming principle[2] and *E. coli*[3] have yielded values close to six million. The possibility of a constant molecular weight with its consequent implications has already been noted[1].

We therefore report the results of some preliminary light-scattering studies of the molecular weight and size of specimens of deoxyribonucleic acid from different sources, which were subjected to preparative procedures as nearly identical as possible. These yield a wide range of values, the molecular weight increasing markedly with the guanine content, as shown in Table 1.

Table 1. MOLECULAR WEIGHT AND SIZE OF DEOXYRIBONUCLEIC ACID MOLECULES IN 0·2 *M* SODIUM CHLORIDE, *p*H 6·8

Source	Base ratio adenine + thymine / guanine + cytosine	Guanine content (moles/100 moles nucleotide)	Molecular weight ($\times 10^{-6}$)	Molecular radius of gyration (A.)
Arbacia lixula	1·59	17·5	2·3	1530
Calf thymus	1·32	21·5	6·0	2240
E. coli	1·0	24·0	9·1	3500
Avian tubercle bacillus	0·4	37·0	14·4* 13·5†	2300* 1400†

* Specimen (1), fibres kept in solvent for three days prior to final centrifugation.
† Specimen (2), fibres kept in solvent for eight days prior to final centrifugation.

Calf thymus deoxyribonucleic acid was prepared by the method of Schwander and Signer[4]. Other specimens of deoxyribonucleic acid were obtained from *Arbacia lixula* sperm, *Escherichia coli* B. and from avian tubercle bacilli, as outlined below. These were modifications of the methods used by Chargaff *et al.*[5] and Zamenhof *et al.*[6]. The washed sperm and micro-organisms, after the latter had been ground with alumina or glass powder in a vibratory ball mill, were extracted three times with 3 *M* and 1·7 *M* sodium chloride respectively. After clarifying by centrifugation, the crude material was precipitated three times in 90 per cent alcohol at − 20° C. Proteins and ribonucleic acids were removed by Sevag's[7] procedure and by treatment with ribonuclease and dialysis against 10 per cent sodium chloride. After further precipitations in alcohol, the specimens were stored in 70 per cent alcohol at 4° C.

After extraction, the fibres were allowed to swell in 0·2 *M* sodium chloride, *p*H 6·8, for 48 hr. before blending for 30 sec. at 10,000 r.p.m. The solution was then shaken for 16 hr. and finally spun in a Spinco ultracentrifuge at 30,000 r.p.m. (mean centrifugal field 60,000 *g*) for 3 hr. Particular attention was given to the identity of these procedures, all of which were carried out at 4° C.

The light-scattering measurements were made at room temperature (~ 18° C.) using the wave-lengths 5461 A. and 4359 A. The results for each specimen agreed within the limits of experimental error, and those given in Table 1 are the mean values so obtained. Concentrations were determined from the phosphorus content using Allen's colorimetric method[8]. Wyatt's value of 9·4 per cent phosphorus for calf thymus deoxyribonucleic acid[10] was assumed throughout, and the values for the molecular weights are therefore subject to small corrections. The values of the refractive index increment, 0·175 at 5461 A. and 0·181 at 4359 A., were measured for calf thymus deoxyribonucleic acid and were used for all specimens. The latter figure agrees to within a few per cent with the most recent value given by Reichmann *et al.*[1]; we note also that our values for the macromolecular parameters of the calf thymus deoxyribonucleic acid are in excellent agreement with those given by these authors.

We are not aware of any previous measurements of the molecular weight of the *Arbacia lixula* or avian tubercle deoxyribonucleic acid; since these have yielded the extreme values for the molecular weight, Zimm plots for these specimens are given in Figs. 1 and 2. With the exception of the second specimen of the avian tubercle deoxyribonucleic acid, all measurements were made on solutions prepared from fibres which were placed in the solvent three days prior to the final centrifugation. For these systems the reciprocal particle-scattering factors were found to be almost linear over the angular range 25°–135°, thus indicating a system of polydisperse Gaussian coils having a weight-to-number average molecular weight ratio of 2. In order to ensure that the high molecular weight found for the avian tubercle deoxyribonucleic acid was not due to insufficient time having been allowed for the fibres to pass into solution, a second specimen was prepared using fibres which had been kept in the solvent for eight days before the final centrifugation. The molecular weight was found to be essentially the same, although the particle shape was significantly changed. A decrease in the particle radius of gyration, together with a pronounced upward curvature of the reciprocal

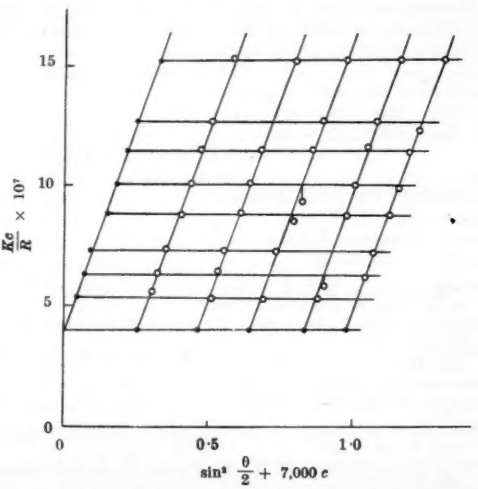

Fig. 1. Zimm plot for *Arbacia lixula* deoxyribonucleic acid in 0·2 *M* sodium chloride, *p*H 6·8. Angular range 25°–70°. Concentrations: 3·68, 6·64, 9·22, 11·9 and 14·0 × 10^{-3} gm./ml. $\lambda = 5461$ A.

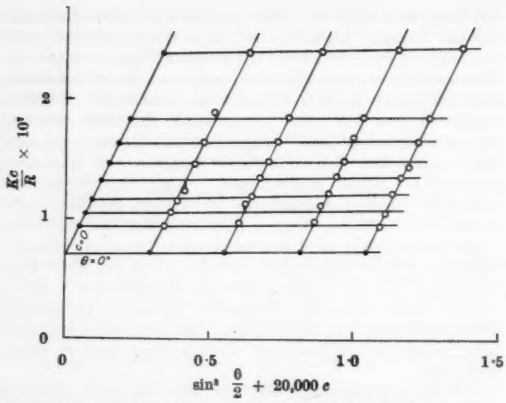

Fig. 2. Zimm plot for avian tubercle deoxyribonucleic acid in 0·2 *M* sodium chloride, *p*H 6·8. Angular range 25°–70°. Concentrations: ▲1·46, 2·75, 4·06 and 5·20 × 10^{-4} gm./ml. $\lambda = 5461$ A.

particle-scattering factor, indicated a more highly coiled unit.

Of the four specimens investigated, the avian tubercle deoxyribonucleic acid molecule is characterized by the fact that its increased weight is not accompanied by a corresponding increase in the radius of gyration; this suggests that the mass per unit length along the chain may be greater for this molecule. Further, its ability to take up a more coiled configuration in solution may be due to intramolecular forces between different parts of the same chain. These findings suggest that, as the guanine content increases, the chains are more strongly bonded by forces which determine both the macromolecular weight and configuration in solution. It is significant that in the twin helical, hydrogen-bonded, structure, proposed for the deoxyribonucleic acid molecule by Watson and Crick[11], the 2-amino group of the guanine base appears to be available for the binding of two chains or for the binding of different parts of the same chain.

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Dissociation of Deoxyribonucleic Acid by Urea

We found[1] that the molecular weight of deoxyribonucleic acid from herring sperm heads, measured by light-scattering in dilute aqueous solution, was reduced from 6×10^6 to 3×10^6 on adding a concentrated urea solution to make the final urea concentration 4 *M*. This halving of the molecular weight was accompanied by a 20 per cent increase in the radius of gyration of the coil. This behaviour is consistent with the twin spiral model of Crick and Watson[2] if it is assumed that the urea splits the hydrogen bonds holding the two molecules together. After removal of the urea by dialysis the 'split' molecule coils up into a much more compact shape[1]; if the dialysis is conducted from solutions containing less than 0·003 per cent deoxyribonucleic acid, the molecular weight remains unchanged at 3×10^6; in more concentrated solutions aggregation occurs and molecular weights ranging up to 2×10^7 have been measured.

Doty and Rice[3] attempted to repeat these experiments with deoxyribonucleic acid from thymus glands but found that in this case urea does not change the molecular weight. To determine whether this failure of thymus deoxyribonucleic acid to dissociate was due to slight differences in technique or to an inherent difference between the deoxyribonucleic acid from herring sperm and thymus we exchanged samples with Prof. P. Doty and confirmed his finding. Since then we have examined several samples of deoxyribonucleic acid prepared by Prof. J. A. V. Butler and Dr. P. F. Davison by the enzyme method described by Butler *et al.*[4] and have again found that material from herring sperm was split by urea whereas that from the thymus gland was not. It seems clear, therefore, that the deoxyribonucleic acids from the two sources, although originally of similar molecular weight, show genuine differences in behaviour.

A further physico-chemical difference between these two types of deoxyribonucleic acid was found in their response to heating for 15 min. in 0·05 per cent aqueous solution to 100° C. In agreement with Doty and Rice[3], we find the molecular weight of thymus deoxyribonucleic acid is unchanged, but that the size of the molecule is decreased. The molecular weight of the material from herring sperm, however, is reduced in molecular weight to $2{\cdot}5 \times 10^6$ if heated in 0·1 *M* sodium chloride.

Since Jungner[5] had reported that thymus deoxyribonucleic acid contained 0·1 per cent magnesium, we decided to test if chelation by metal ions might be responsible for the failure of urea to 'split' it. Preliminary evidence supporting this view was obtained; thymus deoxyribonucleic acid, after treatment with the sequestering agent ethylene diamine tetracetate and its removal by dialysis, was unchanged in molecular weight but was now 'split' by urea to give units of molecular weight of 3×10^6. The dissociation of this material required 30 min. after the addition of the urea, whereas the splitting of herring sperm deoxyribonucleic acid is complete within ten to fifteen minutes.

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Extraction of Collagen from Tissues

In the course of some estimations of deoxyribonucleic acid by Schneider's method[1], we observed incidentally that the hot trichloroacetic acid extraction of the tissue removed the collagen almost completely, judged by estimations of hydroxyproline on the hydrolysates of the solubilized and insoluble material.

We have now examined this method of solubilizing collagen in other tissues with the view of using it instead of the normal autoclaving procedure in conjunction with the method of Neuman and Logan[2] for estimation of collagen from the hydroxyproline content of an acid hydrolysate of the solubilized material. In order to estimate the completeness of the extractions, we estimated the hydroxyproline content of the extracts and of the residual insoluble material. On the basis of a preliminary investigation along these lines using various times of extraction, we decided on two half-hour extractions with **0·3** *M* trichloroacetic acid at about 90° C. followed by two washes with cold trichloroacetic acid. Elastin of dog's aorta does not appear to be dissolved by this procedure, though it is rendered soluble in *N*/10 sodium hydroxide, so that the usual method of estimating it after collagen is not applicable[2,3]. Some results with the method are given in Table 1.

Table 1

	Collagen (gm. per 100 gm. wet weight)	Collagen extracted (per cent)
Rat muscle	0·77	97·4
Rat skin (with hair)	4·52	98·3
Rat tail tendon	15·70	100·1
Rat mammary gland (lactating)	1·47	98·0
Rat liver	0·18	96·4
Ox liver (*a*) pulp	0·25	92·8
(*b*) vessels	5·1	97·5

(*a*) Material pressed through 1 mm. diameter holes in a metal plate.
(*b*) Material retained by perforated metal plate.

The completeness of extraction tends to drop slightly as the collagen content of the material diminishes, possibly owing to increased relative importance of adsorption of gelatin on precipitated proteins. The liver pulp, which gave the lowest extraction, probably contains a large proportion of reticulin which is known to be difficult to solubilize, a difficulty which occurs also with other methods of extraction. This degree of extraction would in any event be quite adequate for many purposes.

The method is quicker and simpler than the usual procedure[2]; it also has great advantages for sampling a large bulk of tissue which is difficult to homogenize. The tissue is roughly broken up and subjected to the first period of heating with trichloroacetic acid. It can then be homogenized very easily in a blender and sampled; tissue containing bone can be dealt with easily in this way.

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Inhibition of Histamine Release in Anaphylaxis

Although the effects of anaphylaxis and chemical histamine releasers are similar and mainly attributable to histamine release, the mechanism by which the release occurs in the two cases is fundamentally different. We have found that lack of oxygen and also inhibitors of oxidative and glycolytic metabolism have a powerful inhibitory action on the release of histamine in anaphylaxis but enhance its release by compound 48/80 (a condensation product of *p*-methoxyphenyl-ethyl-methylamine and formaldehyde) and octylamine.

By the use of minced guinea pig lung from animals sensitized to egg albumin, it is possible to release with the specific antigen 20–40 per cent of the total histamine contained in the tissue. Addition of 1 m*M* iodoacetate reduces this release to 5 per cent or less. Suitable concentrations of compound 48/80 (1 mgm./ml.) and octylamine (0·15 mgm./ml.) also release 20–40 per cent of the histamine content of the tissue; but in the presence of 1 m*M* iodoacetate this release is nearly doubled. Addition of the antigen in the presence of nitrogen produces similar effects, namely, an almost complete inhibition of the anaphylactic release and a potentiation of histamine release by the chemical releasers. It has previously been shown by Parrot[1] that anoxia inhibits the release of histamine in anaphylaxis. The effect of anoxia could be partially reversed by methylene blue; but that of iodoacetate was not reversed by pyruvate.

These results suggest that the release of histamine in anaphylaxis is a process which requires energy and can easily be disrupted. The action of chemical releasers, on the other hand, is enhanced by processes which interfere with normal cell metabolism. These findings m y possibly explain why isolated intracellular particles containing histamine are able to release histamine when treated with chemical releasers[2], but cannot be made to release histamine in anaphylaxis[3].

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Effect of Antibiotics on Indole Synthesis by *Escherichia coli* 7-4

It has been shown (Gibson, Jones and Teltscher[1]) that indole is formed from glucose and ammonium chloride by washed-cell suspensions of a mutant, *Escherichia coli* 7-4, blocked in the conversion of indole to tryptophan. The effect of some antibiotics on the formation of indole has now been studied.

It was found that chloramphenicol, terramycin, aureomycin and streptomycin inhibited indole formation, but penicillin had little effect (Table 1). The minimum concentrations of chloramphenicol, terramycin and aureomycin needed to inhibit indole synthesis corresponded closely to the bacteriostatic concentrations for *E. coli* 7-4 in the liquid synthetic medium described by Davis and Mingioli[2]. As an example of such inhibition, the effect of terramycin on total growth and indole synthesis is shown in Fig. 1.

Table 1. Effect of Antibiotics on Indole Synthesis by *E. coli* 7-4

Addition to indole synthesis system*	Indole formed (mμ*M*./mgm. dry wt. cells)
None	260
Terramycin (1 μgm./ml.)	41
Aureomycin (1 μgm./ml.)	71
Chloramphenicol (5 μgm./ml.)	44
Streptomycin (10 μgm./ml.)	231
(150 μgm./ml.)	35
Penicillin (100 units/ml.)	274
(1,000 units/ml.)	196

* Indole synthesis system. Washed cells from heart infusion agar (0·8 mgm./ml. dry wt.); glucose (0·1 *M*); DL-serine (0·01 *M*); ammonium chloride (0·005 *M*); phosphate buffer (0·1 *M*, *p*H 7·7). Test incubated 5 hr. at 37°.

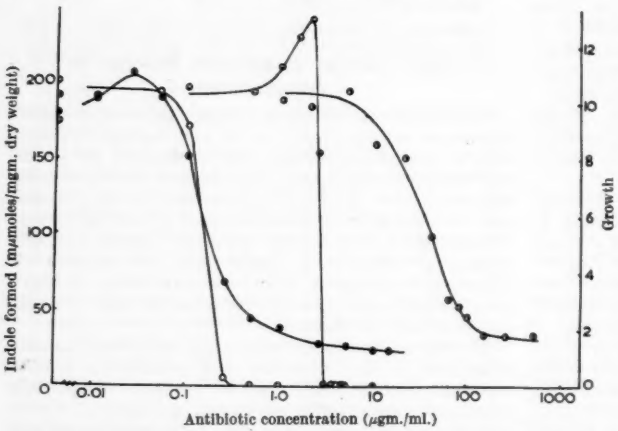

Fig. 1. Effect of terramycin and streptomycin on growth and indole synthesis by *E. coli* 7-4.
—○—○—, Terramycin, growth (expressed as turbidity with *E.E.L.* portable colorimeter); —●—●— terramycin, indole synthesis; —⊖—⊖—, streptomycin, growth (expressed as turbidity with *E.E.L.* portable colorimeter); —◑—◑—, streptomycin, indole synthesis.
Indole synthesis. Substrates and cells as in Table 1. Antibiotics added with substrates and test incubated 4 hr. at 37°.
Bacteriostatic tests. Davis minimal medium plus DL-tryptophan (10^{-4} *M*) incubated 24 hr. at 37°

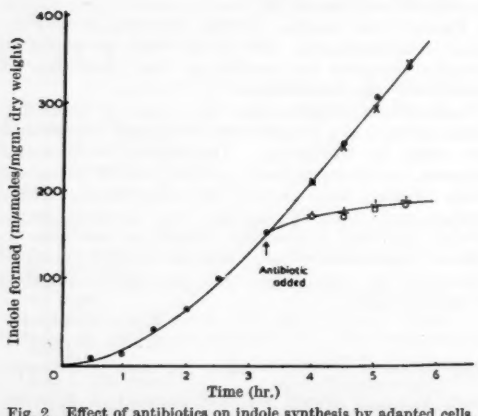

Fig. 2. Effect of antibiotics on indole synthesis by adapted cells. Indole synthesis system. Substrates as for Table 1; cells (0·7 mgm./ml.). Test incubated at 37° and antibiotics added as follow: —●—●—, No addition; —○—○—, terramycin (1 μgm./ml.); —+—+—, chloramphenicol (5 μgm./ml.); —×—×—, streptomycin (150 μgm./ml.)

Chloramphenicol, terramycin and aureomycin have been shown to suppress the formation of adaptive enzymes in *E. coli*[3]; but their interference with indole synthesis is different since the addition of any of these drugs to adapted cells still inhibited synthesis (Fig. 2). Thus the action of these antibiotics on the formation of adaptive enzymes may be secondary to the inhibition of the synthesis of essential aromatic compounds.

Streptomycin differed from the other antibiotics tested in that it did not inhibit indole synthesis at the concentration needed to prevent growth (3 μgm./ml.), but was effective at higher concentrations (Table 1, Fig. 1). Furthermore, the addition of streptomycin (150 μgm./ml.), once indole formation was proceeding at maximum rate, did not interfere with its synthesis (Fig. 2). It appears that streptomycin inhibits some adaptive process concerned in the formation of indole.

Various workers have suggested that antibiotics may interfere with protein synthesis or with the biosynthesis of the aromatic amino-acids (see ref. 4). That chloramphenicol, terramycin and aureomycin may interfere with the same metabolic pathway is suggested by the finding that strains of *E. coli* made resistant to any one of the three drugs showed a cross-resistance to the other two[5].

The present results provide evidence that some antibiotics, at bacteriostatic concentrations, inhibit reactions associated with aromatic synthesis in *E. coli*.

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Protective Action of Vitamin B_{12} in the Hyperthyroid Rat

SINCE thyroxine is known to decrease the efficiency with which phosphorylation is coupled to respiration[1], the possibility suggests itself that vitamin B_{12} may function in hyperthyroidism by restoration, in part at least, of the energy-requiring functions of impaired cells. This has now been examined by a study of the following conjugation systems: acetylation of *p*-aminobenzoic acid, benzoylation of glycine, and synthesis of glutathione.

Groups of six rats (Wistar strain), 120–140 gm. in weight, were maintained on the following laboratory stock diet:

Whole wheat flour	69 parts	Shark liver oil	4 parts
Casein	10 ,,	Sesame oil	4 ,,
Whole milk powder	2 ,,	Calcium carbonate	2 ,,
Dried fish meal	3 ,,	Sodium chloride	2 ,,
Wheat bran	4 ,,		

with modifications as shown (Table 1). Iodinated casein ('Protomone': Cerophyl Laboratories, Kansas City, Mo.) was at 3 per cent level and replaced an equal amount of casein in the diet. Vitamin B_{12} ('Cobionne': Merck) was administered intraperitoneally at 10 γ per rat per day. The animals receiving iodinated casein (group 3) in the diet lost 7–10 per cent body-weight during two to three weeks when they were considered hyperthyroid[1]. Acetylating ability was determined during this period by the method of Bratton and Marshall[2] after intraperitoneal administration of *p*-aminobenzoic acid (1 mgm./300 gm. body-weight) followed by urine collection for the next 24 hr. A small amount of the *p*-aminobenzoic acid was apparently excreted as *p*-aminobenzoyl glycine, which was determined separately in aliquots of the urine[3]. Corrections were made in either case for endogenous excretions.

Blood samples were collected from the tail veins for determinations of erythrocyte glutathione after hæmolysis, plasma being nearly devoid of this metabolite.

At the end of three weeks, the animals were killed; livers and adrenals were quickly excised and chilled for immediate determinations of glutathione[4] and for the *in vitro* synthesis of benzoyl glycine by the liver enzymes. For the latter purpose, the procedure employed was as follows: 0·5 c.c. of 1 : 5 liver homogenate in 0·1 *M* phosphate buffer, *p*H 7·5, was added to a mixture of glycine (0·01 *M*), benzoic acid (0·0025 *M*), potassium dihydrogen phosphate (0·037 *M*), magnesium sulphate (0·0008 *M*), sodium citrate (0·01 *M*) and sodium fumarate (0·0015 *M*) in the concentrations indicated in a final volume of 5 c.c., *p*H being adjusted to 7·5 with dilute potassium hydroxide. All flasks were gassed with oxygen for 10 min. prior to incubation for 3 hr. at 37° with frequent shaking. Reaction was stopped by addition of 0·2 c.c. of *N* sulphuric acid and the benzoyl glycine formed estimated[3]. Values reported in Table 1 represent increments after the incubation period over corresponding zero-time digests prepared similarly.

The results, which are averages for the six animals in each group, show that in the hyperthyroid animals there is a marked reduction in acetylating ability as well as in tissue glutathione as compared to the control group. Vitamin B_{12} supplementation counteracts this condition appreciably.

An observation of interest emerging from this study is the increase in blood glutathione during thyrotoxicosis and its reversal by vitamin B_{12}. This inverse relationship between blood- and liver-levels of glutathione has since been confirmed in other studies now under progress, and is also suggested from the report[5] that there is an increase in erythrocyte glutathione in methionine deficiency.

Iodinated casein has been reported to interfere with vitamin B_{12} absorption[6]. Since vitamin B_{12} is involved in the activation of soluble and protein sulphydryl, its role in carbohydrate and lipid metabolism has been demonstrated[7]; it is also involved in the synthesis of porphyrins and respiratory pigments[8]. It seems, therefore, that the primary manifestation of thyrotoxicosis is a deficiency of vitamin B_{12}, and consequent interference in the generation and utilization of energy-rich bonds coupled with electron transport.

Table 1

Group	Per cent gain in weight (during 3 weeks)	Glutathione in: Liver (mgm./gm., fresh basis)	Glutathione in: Adrenals (mgm./gm., fresh basis)	Blood (mgm./100 c.c.)	Synthesis *in vitro* of benzoyl glycine (mgm./gm. dry liver)	Per cent urinary conversion of *p*-aminobenzoic acid to: *p*-aminobenzoyl glycine	Per cent urinary conversion of *p*-aminobenzoic acid to: N-acetyl *p*-aminobenzoic acid
1. Basal (stock diet)	30·5±7·4*	1·30±0·15*	1·82±0·12*	11·6±1·8*	0·87±0·13*	9·6±0·5*	64±13*
2. Basal+vitamin B_{12}	28·2±7·6	1·40±0·10	1·87±0·18	13·4±3·0	1·10±0·11	12·6±1·2	86± 8
3. Basal with iodinated casein	−8·5±2·3	0·82±0·02	0·97±0·06	33·1±1·4	0·43±0·10	4·8±0·3	32± 5
4. Basal with iodinated casein+vitamin B_{12}	−1·8±3·7	1·11±0·04	1·44±0·03	16·9±2·8	0·63±0·07	7·9±1·5	48± 5

* Standard error.

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Essential Relaxing Factor in Muscle other than Myokinase and Creatine Phosphokinase

Extracts of rabbit skeletal muscle contain factors which play a part in the relaxation of muscle fibre models, such as glycerinated fibres[1–3]. Two of them isolated have been identified with known enzymes: myokinase by Bendall[4] and creatine phosphokinase by Lorand[5]. But these two enzymes, coupled with their co-factors, do not settle all the problems of muscular relaxation because, in the light of our experiments, they do not have any relaxing effect on glycerinated fibres which have been preserved for a long time and exhaustively washed (Fig. 2*a*).

We have shown[3] that the adenosine triphosphate-dependent relaxing factor, in fact, consists of two different components; one occurs in the fraction precipitated by ammonium sulphate at concentrations of 10–20 gm. of sulphate per 100 ml. of extracted solution from muscle, tentatively named 'fraction *A*', and the other in the fraction precipitated by concentrations of 30–40 gm. of sulphate per 100 ml. of extracted solution from muscle, 'fraction *B*'. Each has a moderate relaxing effect on relatively fresh fibres. If the fibres to be tested, however, have been preserved in 50 per cent aqueous glycerol for one month or more at − 10° C. and washed in 0·1 *M* potassium chloride solution for several hours, each fraction by itself no longer has a relaxing effect (Fig. 1, *a* and *b*). The relaxing activity is not recovered until these two fractions are used together (Fig. 1*c*).

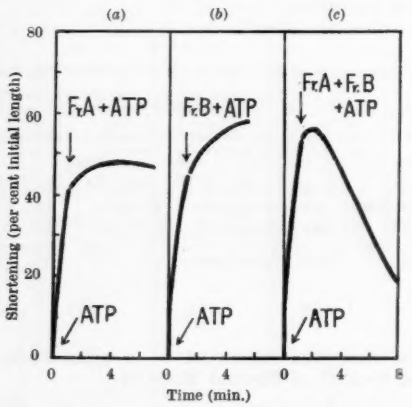

Fig. 1. Effect of fraction *A* and *B* on a muscle fibre shortened in adenosine triphosphate.
ATP = 5 m*M* adenosine triphosphate; Fr. *A* + ATP = 2·2 mgm./ml. of fraction *A* + 5 m*M* adenosine triphosphate; Fr. *B* + ATP = 17 mgm./ml. of fraction *B* + 5 m*M* adenosine triphosphate; Fr. *A* + Fr. *B* + ATP = 2·2 mgm./ml. of fraction *A* + 15 mgm./ml. of fraction *B* + 5 m*M* adenosine triphosphate. All the experiments were performed in 0·15 *M* potassium chloride containing 0·01 *M* magnesium chloride. For fractions *A* and *B* see text

Fraction *A* is highly opalescent, suggesting that it contains a considerable amount of lipid. It has strong adenosine triphosphatase activity, which corresponds apparently to Kielley–Meyerhof's adenosine triphosphatase[7]. No method has so far been found for separating the active relaxing principle from the enzyme. These two substances are quite similar in properties in certain respects: both can be centrifuged at 18,000 *g* for 1 hr. without losing their activity; both are activated by magnesium ions, the optimum of which is about 0·004 *M*, and inactivated specifically by a small amount of calcium ions. Their identity, however, remains to be proved and requires further study.

Fraction *B* contains myokinase and creatine phosphokinase. It is probable that myokinase plays an important part in the adenosine triphosphate-dependent relaxing action of fraction *B*. Indeed, crude myokinase, if combined with fraction *A*, has a lengthening effect on moderately washed fibres (Fig. 2*b*). Nevertheless, the whole activity of fraction *B* cannot be ascribed to myokinase, for this fraction is far more labile to acid than myokinase, and in the case of old and washed fibres, myokinase is ineffective, even when combined with fraction *A* (Fig. 2*c*). Some other factor or factors in fraction *B* evidently participate in relaxation (Fig. 2*d*).

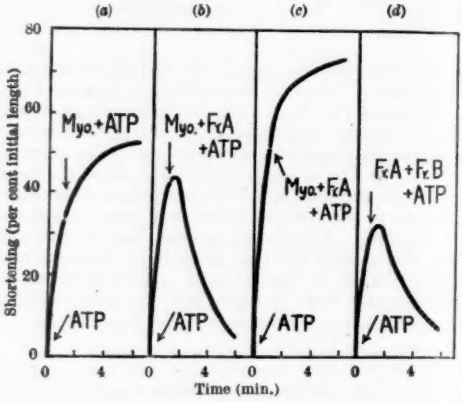

Fig. 2. Effect of crude myokinase and fraction *B* combined or uncombined with fraction *A* on a muscle fibre shortened in adenosine triphosphate.
Myo. + ATP = 0·4 mgm./ml. of crude myokinase (acidified and fractionated by ammonium sulphate) + 5 m*M* adenosine triphosphate; Myo. + Fr. *A* + ATP = 0·16 mgm./ml. of crude myokinase + 5 mgm./ml. of fraction *A* + 5 m*M* adenosine triphosphate; Fr. *A* + Fr. *B* + ATP = 5 mgm./ml. of fraction *A* + 8 mgm./ml. of fraction *B* + 5 m*M* adenosine triphosphate. In (*a*) and (*b*) relatively unwashed muscle fibres were used; (*c*) and (*d*) fibres preserved and washed. Other notes as in Fig. 1

Unless it is aided by fraction *A*, the creatine phosphokinase–phosphocreatine–adenosine triphosphate system[2,5] also has no effect on old and washed fibres.

As described above, fraction *A* is essential for the relaxation of muscle fibre models. Experiments by other workers[1,2,4,5] have probably been conducted on fibre preparations which still contain some of the active principle of this fraction.

Details of this work will be published elsewhere.

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Maturation Divisions of the Ova in the Pseudophyllidean Cestode, *Eubothrium crassum* (Bloch)

Much confusion still exists in generalized accounts of life-histories of parasitic platyhelminthes concerning the position of the egg at the time of its maturation divisions and therefore about the exact time of fertilization. Indeed, it has been suggested[1] that normal gametogenesis does not occur in many cestodes of the Cyclophyllidea, Tetraphyllidea and Trypanorhyncha. In a number of digenetic trematodes, on the other hand, it has been carefully shown by various workers, notably Chen[2], Rees[3], Stephenson[4] and Willmott[5], that meiosis in the ovum is normal and occurs in that part of the uterus immediately beyond the central chamber of Mehlis's gland. The ova move into the uterus at this point surrounded by yolk cells and begin maturation divisions at once while the shell is being laid down around the egg complex, which comprises one ovum, yolk cells and spermatozoa.

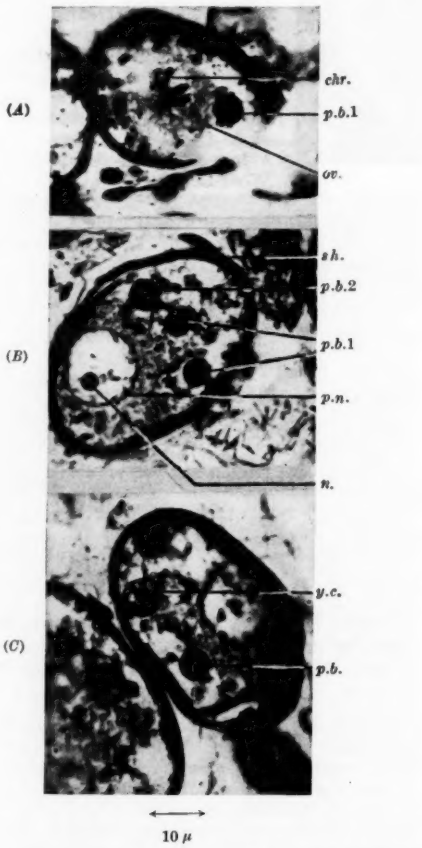

Fig. 1. Egg complex in uterine duct. Material fixed in Bouin's fluid at 70° C., sectioned at 6 μ and stained with Heidenhain's iron hæmatoxylin. *A*, first polar body and chromosomes at second maturation division metaphase; *B*, female pronucleus with well-defined nucleolus, second polar body, and first polar body divided; *C*, differentiation of yolk cells and polar body. *chr.*, Chromosomes; *n*, nucleolus; *ov.*, eccentrically placed female cell; *p.b.*1, first polar body; *p.b.*2, second polar body; *p.n.*, female pronucleus; *sh.*, shell; *y.c.*, yolk cell

Normal maturation divisions of ova have been reported in a few cestodes, both primitive and advanced, by much earlier authors, some of whom found polar bodies in association with the ovum. Young[1], however, after working on some of the more advanced cestodes mentioned above, considered that these workers had confused the polar bodies and yolk cells. The only work published since then on this aspect of cestode cytology is that of Motomura[6]. He gives convincing evidence of normal oogenesis in the monozoic cestode, *Archigetes appendiculatus*, and shows in a series of figures how the whole process of maturation, fertilization and shell formation is very similar to the condition described in the various trematodes and occurs in an analogous position, that is, immediately beyond the central chamber of Mehlis's gland. But until now there have been no photographs of the egg complex in any cestode.

I find that my results on *Eubothrium crassum*[7] agree very closely with those of Motomura, so that the same general scheme is demonstrated once again, this time in a pseudophyllidean cestode. In this and in more advanced cestodes, however, a definite uterine duct exists between the oviduct and Mehlis's gland, and it is this which is usually referred to as the 'fertilization canal' or 'befruchtungsgang'. Invariably, in my sections, this part of the uterine duct was empty and surrounded by slime gland cells, both features suggesting that this is a duct through which the contents pass quickly, while the uterine duct beyond Mehlis's gland harbours the egg complex for some time. In addition, the accompanying photographs show the chromosomes of the ovum in this position at the second maturation division with the first polar body undivided (Fig. 1,*A*), and also the pronucleus stage with its large nucleolus and second polar body (Fig. 1,*B*). At this pronucleus stage the first polar body is seen to be divided—a feature not observed by Motomura. Fig. 1,*C* shows how the polar bodies are easily distinguished from yolk cells.

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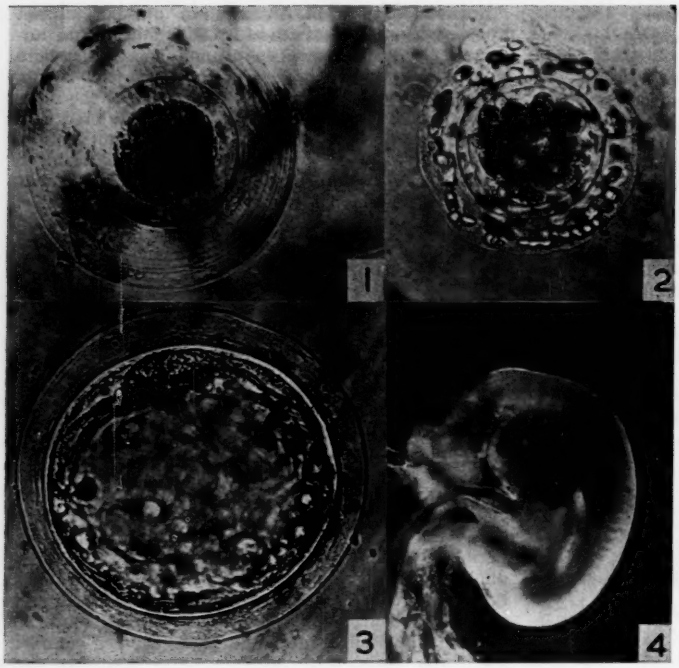
Transfer of Mammalian Ova between Species

The intra-specific transfer of mammalian eggs has now been developed into a well-established technique[1]; but apart from two recent communications[2,3], relatively little information is available concerning either inter-generic or inter-specific transfer. The absence of any reliable method for the culture of sheep eggs *in vitro* led us to investigate whether they could develop normally following transfer to the genital tract of the rabbit. The reproductive pattern of the rabbit makes it eminently suitable for a study of this nature.

Sheep eggs were obtained from the Fallopian tubes of ewes treated with pregnant mare serum and mated



2½–3 days prior to the operation. The technique employed for the recovery of the eggs was the same as that previously described[4]; sterile sheep serum was used as the flushing and transfer medium in all experiments. Pending transfer, the eggs were stored at 10°–16° C. for 20–45 min. To date, eighteen eggs, comprising four 2-cell, four 4-cell, four 6-cell, five 8-cell and one 12-cell, have been transferred to the Fallopian tubes of seven does which had been mated with a vasectomized buck 2–11¼ hr. previously. Four to five days later the rabbits were killed and the eggs recovered from the uterus (four cases) or the Fallopian tubes (one case); in the remaining two does, none of the five eggs transferred was recovered. Out of the eighteen eggs transferred, nine were afterwards recovered together with a high proportion of the rabbits' own eggs. Whereas all the rabbit eggs were found uncleaved (Fig. 1), the sheep eggs had continued to cleave normally; at recovery there were six 32-cell morulae (Fig. 2), and two 6-day blastocysts and one 8-day blastocyst (Fig. 3). Although the sheep eggs had acquired the mucin layer characteristic of the rabbit egg, no difficulty was encountered in establishing their identity owing to the inherent structural differences, and the characteristic colour and density of the ooplasm.

The two 6-day blastocysts were re-transferred to a non-pregnant ewe in which ovulation had occurred six days previously. When this animal was killed sixteen days later, two normal embryos were found (Fig. 4). One morula was also re-transferred to another recipient; but no trace of it could be found at autopsy 13½ days after transfer.

It is concluded that sheep eggs can remain viable in the genital tract of the rabbit for a period of not less than five days, and are capable of developing from the 2-cell egg to at least the 8-day blastocyst stage. The deposition of the mucin layer on the transferred sheep eggs appears not to interfere with their subsequent development.

Our results strongly support the view that the species differences which exist in the rates of cleavage are inherent in the eggs[5]; they also provide some evidence against the suggestion that the success of interspecific ovum transfer is related to the ability of the species concerned to hybridize[3].

It is hoped to develop the egg-transfer technique outlined above as a means of testing the viability of sheep eggs in the early stages of development. Moreover, the use of the reproductive tract of the rabbit as an 'incubator' may enable the successful long-distance transport of sheep eggs.

These experiments form part of the investigations on ovum physiology being carried out at the Agricultural Research Council Unit of Reproductive Physiology and Biochemistry; we are grateful to Dr. T. R. R. Mann for reading and discussing the manuscript. One of us (R. L. W. A.) is in receipt of a bursary from the New Zealand Wool Board.

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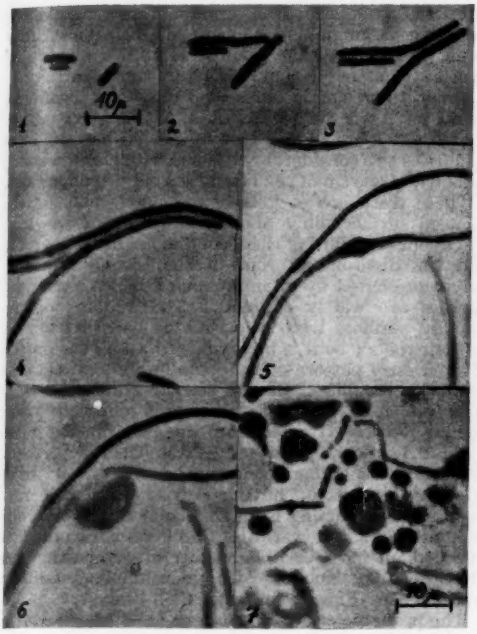
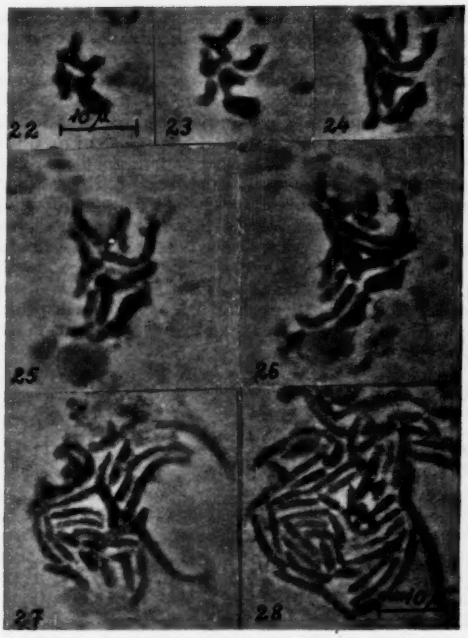
Plasma Globules of *Salmonella enteritidis* arising under the Influence of Penicillin and their Reversion to the Original Bacillary Forms

Changes in the behaviour of *Salmonella enteritidis* var. *danysz* have been studied by the agar block method and recorded microcinematographically.

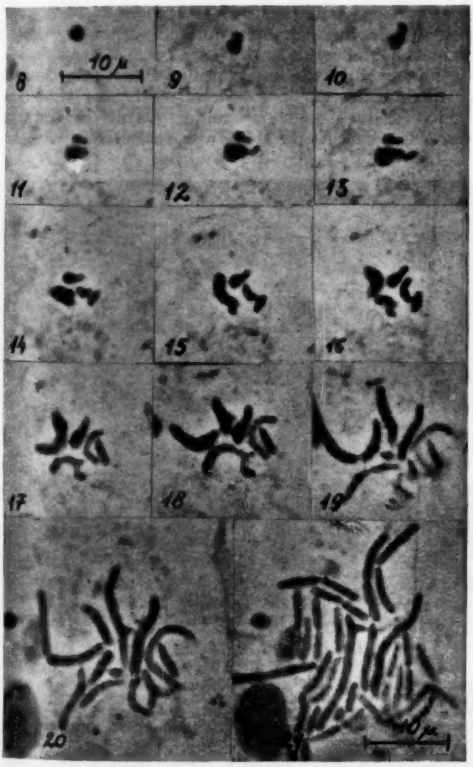
Under the influence of 30–40 i.u. of penicillin, the bacteria increase in length (Figs. 1–4). These elongated bacteria develop a spindle-like swelling at the middle of the body (Fig. 5), which bursts after some time, discharging its contents (Fig. 6). This is followed by the disruption of the elongated filamentous forms, some parts of which become swollen and liquid. At this time the pulsating liquid material from burst spindles and disintegrated filaments subdivides into minor globules (Fig. 7).



Figs. 1–7. Plasma globules arising on exposure to penicillin. (3-hr. process. Photomicrographs enlarged from selected single exposures from the film)



Figs. 22–28. Reversion through intermediate forms which arose from plasma globule in two hours (recorded cinematomicrographically)



Figs. 8–21. Development of bacterial microcolony from a single plasma globule in three hours (cinematographic appearance)

The forms arising in the course of exposure to penicillin were gently washed with serum broth on the coverslips and transferred to penicillin-free blocks to be studied for regeneration. The following observations were made.

The remains of the rods did not regenerate, but the smaller protoplasmic globules developed, as shown in the photomicrographs 8–21 and 22–28, through an intermediate stage of irregular forms, into typical or atypical forms. The fragments thus originating from one and the same globule apparently differ in their significance.

The full report of this work is to be published in *Acta Biologica Hungarica*.

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Origin of Man

Orowan[1] suggests that the high uric acid concentration in the blood of human beings and anthropoids, as compared with other mammals, may be a cause of their intellectual development. He holds that uric acid has the same stimulatory effect on the brain as caffeine and theobromine.

This hypothesis can be tested. Normal human plasma contains about 40 mgm./litre of uric acid. Since the methylpurines are stimulants, the effect of uric acid cannot well be maximal. The condition of hyperuricæmia, in which the plasma uric acid is raised to about 80 mgm./litre on an average, is

genetically determined, and sometimes gives rise to gout. It seems to be present in nearly 1 per cent of adult Americans.

If Orowan's hypothesis is correct, two conclusions follow. Hyperuricæmics are on an average more intelligent, or at least less susceptible to some kinds of fatigue, than others; and a given dose of methylpurine has less effect on them. It is a good rule not to accept a hypothesis until such tests of its validity as can readily be made have given results confirming it. I think, therefore, that until hyperuricæmics have been studied in this way, Orowan's hypothesis should be regarded as provisional. If, on the other hand, hyperuricæmics are found to differ significantly from the rest of us in their mental processes, it will probably be accepted as an important contribution to the theory of evolution.

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The First Australopithecine Fragment from the Makapansgat Pebble Culture Stratum

During October 1954, Mr. C. K. Brain[1] discovered 129 trimmed, utilized or damaged stones *in situ* in the 18-ft. red, gravel-bearing, sandy layer 25 ft. above the australopithecine-carrying grey breccia at the Makapansgat Limeworks site. Of these, seventeen were claimed by Prof. C. van Riet Lowe to be undoubted Developed Kafuan artefacts, fifteen being of deeply leached dolomite, one of vein quartz and one of dark grey quartzite.

The generous financial assistance afforded to Prof. van Riet Lowe and to me by the Wenner-Gren Foundation for our separate programmes in Makapansgat Valley has enabled us to pursue a joint programme at the Limeworks site this year. Sorting of the dump was resumed in March by Mr. Alun R. Hughes, and in the following month he was joined by Mr. Revill Mason, assistant archæologist in the Union Archæological Survey, to initiate a systematic excavation of the Limeworks Cone, an immense conical block with a basal diameter of approximately 150 ft., the collapse of which subsequent to the earlier mining operations had exposed in the cavern overhang the stratification reported by Brain (*loc. cit.*). Père E. L. Boné, of the University of Louvain, and Mlle. Suzanne Jean, of the Musée de l'Homme, Paris, also assisted in the work during April.

These field-operations have resulted in the recovery of several thousands of pebbles, the artefact content of which will doubtless form the subject of further archæological communications. The purpose of this interim communication is to announce the recovery from the pebble bed of several fossil fragments, including a single elephantine enamel plate, four small pieces of a long bone of some large mammal such as elephant or rhinoceros and, most important, a small right australopithecine maxillary fragment found on April 30 by Mr. Alun R. Hughes. Only 4 cm. × 2·5 cm. × 1·5 cm. in size, it nevertheless comprises two considerably damaged (first and second) molars and the tip of the buccal second premolar root.

These teeth are so grossly damaged that, of the occlusal surface, only about two-thirds of the first and about one-third of the second molar are preserved, and the disto-buccal root of the second molar is only represented by its impression: hence both pulp cavities are widely exposed. The remains of the occlusal surfaces have also suffered attrition almost to their roots; so it is impossible to assess the nature of their cusp pattern even to the limited extent that could be diagnosed in the second adult palate of *Australopithecus prometheus*[2] of still more advanced age previously extracted from the grey breccia itself.

That *A. prometheus* specimen from the grey breccia, however, displaying comparable and even more advanced attrition, having a rather similar root exposure and coming from the same Limeworks site though from a lower and different stratum, has afforded an indispensable means of comparing this mutilated, but none the less identifiable, maxillary fraction (see Figs. 1 and 2).

The probable crown dimensions (*M*1, 14·0 × 14·5; *M*2, 14·25 × 15·0) of these mangled molars compare reasonably well with those found for the corresponding teeth in the second (? female) promethean palate (*M*1, 13 × 14; *M*2, 14 × 15); those in the first female promethean palate[3] were somewhat smaller (*M*1, 12·5 × 12·8; *M*2, 14 × 14). Morphologically, the only gross detectable divergences from the *A. prometheus* teeth are that the distinct grooves on their single palatal (or lingual) roots are broader and shallower on both the molars

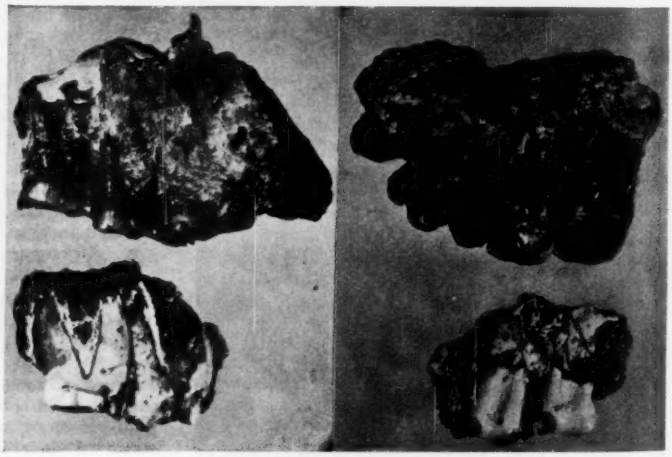

Fig. 1

Fig. 2

(1) Lateral (buccal) view of right maxilla of *Australopithecus prometheus* (above) from the grey breccia at Makapansgat with the first and second premolars and first and second molars in position. Below it the broken first and second molars in the australopithecine maxillary fragment from the pebble stratum in the overlying red breccia are even more distinctly visible. × 4/5

(2) The same two specimens from the medial (lingual or palatal) aspect to display the prominent grooves on the lingual roots of the first and second molars in both these australopithecine maxillæ. × 4/5

of the fragment from the pebble stratum than on those in the second specimen from the grey breccia, and that the roots of the teeth in this pebble stratum *Australopithecus* are distinctly longer and more robust. From his extensive range of comparative australopithecine material from Sterkfontein, Mr. J. T. Robinson has been able to assure me that these divergences are within the range of dental variation for *Australopithecus* (*Plesianthropus*) *transvaalensis*. Stoutly and distinctly three-rooted molars are normal for all the Australopithecinae, as is also the presence of a more or less well-defined groove on the lingual aspect of the single palatal (lingual) root.

The significance of the specimen therefore rests at present in its providing the first concrete evidence that an australopithecine type, broadly comparable with *A. prometheus*, was contemporaneous with, and may have been responsible for, the concomitant pebble culture found in this sealed Central Transvaal cavern deposit. Thereby it not only justifies the original nomenclature and simultaneously enhances the hominid status of the Australopithecinae group, but also demonstrates the earliest known direct association of such a primitive human type with that most primitive of all known lithic cultures in southern Africa.

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Genetic Control of Sodium and Potassium Concentrations in the Red Blood Cells of Sheep

RECENTLY, it has been shown that an examination of the concentrations of sodium and potassium in the red blood cells of sheep enables two types of animal to be recognized within a breed[1]. Sodium concentration varies inversely with potassium concentration, and determination of the latter allows the two types to be distinguished. These two types have been called 'high potassium' (*HK*) and 'low potassium' (*LK*). A large number of repeated examinations of many sheep have been carried out, and in no case has the electrolyte type of any sheep changed from *HK* to *LK* or vice versa.

The percentages of the two types within samples of the Scottish Blackface and Cheviot[1] and other breeds (Evans, J. V., and Mounib, M. S., unpublished results) varied considerably from breed to breed. This suggested a genetic variation which has now been investigated.

Scottish Blackface ewes were mated with rams of three breeds and were typed together with all available progeny. Sodium and potassium were estimated by flame photometer. Whole blood, which had been diluted 1/500 or 1/400 with distilled water, was used. The results are shown in Table 1.

LK rams fall into two classes: those leaving both kinds of offspring (Blackface rams (vii)–(xiii)) and those (rams (i)–(vi), the remainder) leaving nothing but *LK* offspring whatever the phenotype of the ewe. *HK* rams when mated to *LK* ewes produced both kinds of offspring, but mated to *HK* ewes only *HK* offspring. It appears that *HK* is a recessive character, and *LK* rams may be either homozygous or heterozygous for a gene affecting the electrolyte type of red blood cell. These results do not provide much information on the segregation of the gene, the most informative matings being those of heterozygous *LK* rams with *HK* ewes. Taking only sibships with at least one *HK* member, there are 9 *LK* to 8 *HK* animals. This ratio is biased due to the exclusion of sibships which by chance contained no *HK* members, although sired by a heterozygous ram; but when corrected for this bias, does not significantly differ from the expected 1 : 1.

Table 1. RED BLOOD CELL TYPE OF PROGENY FROM MATINGS OF RAMS AND EWES OF VARIOUS PHENOTYPES

Rams			Ewes					
			LK		*HK*		Unknown	
Breed	No	Red blood cell type	Progeny					
			LK	*HK*	*LK*	*HK*	*LK*	*HK*
Southdown	(i)	*LK*	16		7		5	
	(ii)	*LK*	4		11			
Suffolk	(iii)	*LK*	4		6			
Scottish Blackface	(iv)	*LK*					6	
"	(v)	*LK*	1		2		3	
"	(vi)	*LK*			2		2	
"	(vii)	*LK*	3	2			1	
"	(viii)	*LK*	1		2	2	1	2
"	(ix)	*LK*	1		2	1	2	
"	(x)	*LK*	1	1	2	1	1	1
"	(xi)	*LK*	1		2	2	1	
"	(xii)	*LK*	2		1	2	1	1
"	(xiii)	*LK*					4	4
"	(xiv)	*HK*	3	3		4		
"	(xv)	*HK*	4	7		8		

In the British breeds of sheep considered here, it appears that the balance between sodium and potassium in the red blood cells can be substantially modified by a single gene difference. It would be of interest to determine the relationship to the intermediate type found by Kerr[2].

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'Homing Instinct' in Sea Trout

LITTLE is known about the 'homing instinct' in sea trout. Lamond[1] gives several interesting examples of sea trout marked and recaptured in successive years in the same tributaries of rivers flowing into Loch Lomond, and Nall[2] has recorded similar results for sea trout in South Uist. There, two sea trout marked in small lochs were recaptured the following year in the lochs in which they had been marked, and another was recaptured after an absence of two years, again in the loch in which it had been marked. In each case the sea trout had turned into a minor stream instead of following the main stream.

While tagging sea trout in some of the spawning burns of the River Dee, Aberdeenshire, during November 1954, six tagged sea trout were recaptured in three of these burns. Each of these was recaptured in the same burn as that in which it had been tagged

almost exactly twelve months previously. Two of these fish were recaptured on the same stretch of gravel as that on which they had been captured the previous year; both were half-spent females. All identifications are supported by scale examinations. No instance occurred of the recapture of a sea trout, tagged in 1953, in a different spawning burn the following year.

These observations suggest that sea trout return to their native stream and that they spawn at approximately the same time of year each year.

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Transformation of the *Lewis* Groups of Human Red Cells

In general, the blood-group antigens appear to form a permanent part of the human red cell *in vivo*; they persist throughout the life of the cell not only under normal conditions, but also after transfusion into the circulation of a recipient with a different set of antigens. Moreover, antigens characteristic of the recipient do not appear upon the transfused cells. These statements have been shown to be true for the *ABO*, *MNS*, *Rh*, *Lutheran*, *Kell*, *Duffy* and *Kidd* antigens; but the *Lewis* antigens have not previously been investigated in this respect.

The *Lewis* system was discovered by Mourant[1] in 1946: the red cell antigen Le^a is the only blood-group antigen yet known which is inherited as a Mendelian recessive character[2]. The antigen Le^b has so far defied precise genetic analysis, and the gene controlling it may not be allelic to that for Le^a. The antigens may be detected on the red cell and in the serum and secretions. There are three red-cell phenotypes occurring naturally in adult blood as shown in Table 1.

Table 1

Red cell agglutination reactions with anti-Le^a	Red cell agglutination reactions with anti-Le^b	*Lewis* substances present in serum Le^a	*Lewis* substances present in serum Le^b
+	−	+	−
−	+	trace	+
−	−	−	−

Grubb and Morgan[3] first showed that the *Lewis* substances are present in secretions and serum, and Grubb[4] suggested that the *Lewis* antigens are primarily tissue antigens. A blood-group antigen showing somewhat similar behaviour is found in cattle—this is the *J* system: the *J* substance is present on the red cells and also in the serum. Stormont[5] has shown that *J*-negative cells acquire *J* substance from the plasma *in vivo* and *in vitro*. It is known that the Le^a reactivity of the red cell diminishes after repeated washing[3], and Brendemoen[6] showed that the washings inhibited anti-Le^a serum.

It was thus of interest to see whether the *Lewis* red cell antigens were changed *in vivo* after transfusion into a patient of different *Lewis* group. A transfusion from an $Le(a+b-)$ donor was given to a patient of group $Le(a-b+)$. When the two kinds of blood in a post-transfusion sample from the patient were separated (by differential *Rh* agglutination) the donor's cells were found to have become $Le(a+b+)$.

The transformation can be reproduced *in vitro*. The results of mixing group A_1 red cells and plasma of different *Lewis* phenotypes are shown in Table 2. 1 volume of packed red cells to 10 volumes of heparinized plasma (containing streptomycin and terramycin) were continuously shaken at 35° C. The plasma was renewed every 24 hr.

Table 2 shows that $Le(a+b-)$ cells, after 24 hr. in $Le(a-b+)$ plasma, have become $Le(a+b+)$; $Le(a-b+)$ cells in $Le(a+b-)$ plasma have also become $Le(a+b+)$. (The results were the same when *O* cells and plasma were used.) It was further observed that after three days $Le(a+b-)$ and $Le(a-b+)$ cells lose their antigens to $Le(a-b-)$ plasma, while the $Le(a-b-)$ cells can acquire either antigen.

Table 2. Reactions of Red Blood Cells with *Lewis* Antisera after Incubation in Plasma from Different Donors for 24 hr.

Plasma from persons of *Lewis* phenotype	*Lewis* substances in the plasma Le^a	*Lewis* substances in the plasma Le^b	Red cells of *Lewis* group $Le(a+b-)$ reactions with anti-Le^a	Red cells of *Lewis* group $Le(a+b-)$ reactions with anti-Le^b	Red cells of *Lewis* group $Le(a-b+)$ reactions with anti-Le^a	Red cells of *Lewis* group $Le(a-b+)$ reactions with anti-Le^b	Red cells of *Lewis* group $Le(a-b-)$ reactions with anti-Le^a	Red cells of *Lewis* group $Le(a-b-)$ reactions with anti-Le^b
$Le(a+b-)$	+	−	+	−	+	−	+	−
$Le(a-b+)$	trace	+	+	+	−	+	−	+
$Le(a-b-)$	−	−	+*	−	−	+*	−	−

* After three days, these reactions were extremely weak, whereas the other agglutination reactions were almost as strong as those given by fresh cells.

These findings may be correlated with the aberrant *Lewis* reactions given by the red cells of infants[2] and pregnant women[7] (where perhaps the normal level of *Lewis* substances in the plasma is disturbed). The absence of the $Le(a+b+)$ phenotype in adults may be accounted for by the low level of Le^a substance in the serum of $Le(a-b+)$ people.

It seems possible that red cells simply adsorb the *Lewis* antigens *in vivo* and that the fundamental expression of the system is to be found in the serum antigens.

We wish to thank Dr. W. M. Davidson, of King's College Hospital, for sending blood from patients who had been transfused.

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Colour Anomaly, the Rayleigh Equation and Selective Adaptation

So long ago as 1878, von Kries[1] reported that adapting lights fail to upset colour matches. This observation was modified in 1934 by Prof. W. D. Wright, who showed that lights of very high intensity, above about 15,000 photons, do upset colour matches[2]. Wright considers the breakdown at glare intensities to be due to radical photochemical changes. G. S.

Brindley has recently reported a detailed investigation of this breakdown at high intensities[3]. It might be suggested that the original findings of von Kries—that matches do not break down after adaptation with intensities within the normal range—has important implications for theories of colour vision, and in particular for the explanation of the Rayleigh equation.

I have confirmed the finding for thirty normal and four anomalous observers, using a Nagel spectrographic anomaloscope, and Ilford 'spectral red' and 'spectral green' filters for the adapting lights. After adaptation to red light, both the monochromatic yellow field and the red + green mixture field of the anomaloscope appeared green, the match remaining true. After adaptation to green light, both fields appeared red, the match again remaining true. In the case of two protanomalous and two deuteranomalous subjects, it was found that their matches also held after selective adaptation, though their red + green mixtures were, of course, different from the normal observers' mixture, as was found to be the case by Lord Rayleigh, in 1891.

Now since matches hold after adaptation, although subjects with defective colour vision require abnormal mixture intensities to make their match, it appears that the mechanism of colour anomaly must be different from that of selective colour adaptation. But this difference is not generally made evident in discussions on colour vision.

On a trichromatic theory in which no special yellow receptor system is postulated—yellow perception being attributed to combined activity of red and green systems—we should expect the match to hold after adaptation, since the perception of yellow is supposed to be the result of red + green mixture whatever the spectral composition of the stimulus light. Not only is the finding that matches do hold after selective adaptation compatible with a trichromatic theory, but also it may be regarded as evidence against the supposition that there is a special yellow receptor system functional in the foveal region of the retina. A special yellow receptor would be stimulated by the monochromatic yellow field, but would be comparatively unaffected by the adapting light, if this is red or green. If it were affected, it could scarcely be supposed to produce a shift towards red or green, but only a reduced sensitivity to yellow light, which again would not allow the match to hold after adaptation.

The stability of colour matches with selective adaptation up to high intensities thus provides at least *prima facie* evidence against a foveal yellow receptor system. This is strengthened by Brindley's finding (*op. cit.*) that when the match does break down with very high adapting intensities, increase in red light is always required to restore the match, no matter what the colour of the adapting light. If selective adaptation be supposed to depress the sensitivity of the stimulated systems (for which there is a great deal of evidence[4]) whereas anomaly is attributed to abnormal spectral *positions* of the response systems, then there is no longer any paradox in the fact that colour adaptation does not produce a change in colour matches while the anomalous eye requires abnormal mixture intensities to make the match.

We may tentatively conclude that these facts (*a*) provide evidence against a foveal yellow receptor system, and (*b*) suggest that colour anomaly is due to abnormal spectral positions of the fundamental response curves, rather than to abnormal sensitivities, or to neural leakage[5] across receptor systems.

I thank Prof. W. D. Wright, of the Imperial College of Science and Technology, London, for valuable discussions.

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Semiconductivity of a Type IIb Diamond

It is a common opinion that diamond is an insulator at room temperature. Diamonds are known to occur in two types[1], classified as I and II. In 1952 it was suggested[2] that type II be further subdivided into II*a* and II*b*; type II*a* is an insulator with a resistivity of about 10^{16} ohm-cm., whereas type II*b* is a semiconductor[3]. Although this semiconductivity would point to impurities, I am inclined to the view that some type of crystal imperfection may be the primary cause.

In this communication it will be shown that in a temperature-range slightly above room temperature, type II*b* diamonds exhibit conductivity which depends on temperature, the relation taking the form $\exp(-W/2kT)$. The energy gap between the imperfection level and the conduction band (or the valence band, as the case may be) of the diamond examined in our laboratory was found to be 0·70 eV., which is about the same as the energy gap of germanium in the intrinsic range. This value is appreciably smaller than the energy gap of diamonds in the intrinsic region, which amounts to about 6 eV.

The size of the diamond, which came from the Premier Mine, South Africa, was 6·5 mm. × 2·0 mm. × 1·9 mm.[3]. A thin layer of silver was deposited on two opposite faces (size of each face, 6·5 mm. × 2·0 mm.) and the stone was then clamped between two silver electrodes. A constant voltage of 25 V. was applied over the electrodes. The diamond was held in a holder which was placed in a furnace. Table 1 shows the temperature $T°$ abs. at which the electrical current through the diamond was measured, the electrical current i in milliamp., the resistance R in ohms as calculated by applying Ohm's law, log R and the value of $1/T$ abs. From a graph of log R against $1/T$ abs. and the formula $\rho = A \exp W/2kT$, the energy gap W was calculated. In this formula, ρ is the resistivity, A a constant and k the Boltzmann constant. At $T = 293·3°$ abs., $\rho = 7·1 \times 10^5$ ohm-cm. The observations were complicated by the fact that, on applying the voltage, the current rose to an initial value followed by a slight drop which was of the order of a few per cent. The final value was measured after a few seconds, and this value was used for drawing the graph. This drop in current, relatively higher at higher currents, was in all probability due to polarization or a space-charge effect.

The figures of Table 1 were obtained by starting at 18·7° C. and gradually increasing the temperature. Going the reverse way, that is from higher to lower temperatures, a type of hysteresis was encountered,

Table 1

T (° abs.)	i (m.amp.)	$R \times 10^{-5}$ (ohms)	log R	$\frac{1}{T} \times 10^3$
291·9	0·236	1·059	5·025	3·426
293·3	0·252	0·992	4·997	3·410
297·1	0·290	0·862	4·936	3·366
299·5	0·325	0·769	4·886	3·339
301·2	0·346	0·723	4·859	3·320
303·3	0·390	0·641	4·807	3·297
304·7	0·418	0·598	4·777	3·282
307·1	0·472	0·530	4·724	3·256
308·7	0·502	0·498	4·697	3·239
310·1	0·523	0·478	4·679	3·225
312·3	0·584	0·428	4·631	3·202
314·5	0·632	0·395	4·597	3·180
317·5	0·727	0·344	4·537	3·150
319·9	0·776	0·322	4·508	3·126
321·7	0·828	0·302	4·480	3·109
323·1	0·868	0·288	4·459	3·095

the (i,T) graph being shifted in the direction of the i-axis. This shift amounted to 21 per cent at 30° C. under the experimental conditions of cooling the furnace in contact with the air of the room. The hysteresis would mean that the electrons are subject to a delay factor on falling back into the lower energy-level. The original state of the diamond is, however, fully restored in the course of time when left at room temperature, which shows that the conductivity is purely electronic.

The diamond can be used as a crystal rectifier, as was verified by measuring forward and reverse current after the stone had been provided with a silver layer on the one side and a point contact on the other side. At a temperature of 200° C. and 5 V., the forward current was 100 microamp., the reverse current practically nil; currents of the order of a few milliamperes were observed at 125 V. The extraordinary aspect of the semiconductivity of type II*b* diamonds is obvious from the fact that some of these may carry currents of the order of 10 amp. at 125 V. There is an indication that at such high currents permanent changes are produced.

We have also verified that all blue diamonds are of type II*b*. There are, however, type II*b* diamonds which do not show a blue coloration. The example discussed in this communication was slightly brownish. Two blue diamonds have been analysed spectrochemically, the only impurity element found being silicon. As the valency of this element is four, it could scarcely act either as a donor or an acceptor atom.

Blackwell and Sutherland expressed the opinion[4] that the type II diamond is a normal pure diamond, whereas all type I diamonds have some impurity or imperfection in their structure which would account for the anomalies of this type. In a later publication[5], Sutherland, Blackwell and Simeral gave further evidence of the perfection of type II, based on spectrographic measurements. Our semi-conducting diamond, in view of its transparency in the ultra-violet, would be of type II*S* according to Sutherland's nomenclature; but it is not a perfect crystal, nor is it a chemically pure diamond.

Lark-Horovitz and co-workers have shown that lattice disorder may produce p-type conductivity, the lattice defects acting as acceptors[6]. James L. Brophy, who examined the Hall effect of a blue semiconducting diamond, has informed me (private communication) that the sample was p-type over the entire temperature range — 40° to 60° C. He established an activation energy of 0·35 eV., as was also found for the diamond examined by Leivo and Smoluchowski[7].

I thank Industrial Distributors (1946), Ltd., for making the diamond available, and in particular Mr. E. T. S. Brown, whose stimulating interest in research on diamonds is gladly acknowledged. I am also grateful for information given by Mr. J. J. Brophy, of the Armour Research Foundation, of the Illinois Institute of Technology, Chicago.

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Radar and Phosphorescence at Sea

The idea of ship-borne radar stimulating phosphorescence in the sea was first put forward by Captain F. G. Baker of M.V. *British Premier* in the *Marine Observer* (October 1952). The next case was the S.S. *Strathmore*, Captain J. M. Plaice, in the same journal (January 1954). This ship saw patches of light which flashed about once a second, though there was none of the usual small specks of phosphorescence in the ship's wake or bow wave. When the radar was switched off, the patches near the ship faded out, though some distant ones were still faintly visible. On switching the radar on again, the patches reappeared near the ship, but less brightly, and soon disappeared altogether. These reports were referred to authorities in England, including the Naval Weather Service and the Institute of Navigation. Their opinion was that it was most unlikely that radar could stimulate any phosphorescence in the sea, but invited more reports.

At 2 a.m. local time on September 5, 1954, the M.V. *Malaita* was steering a course of 210° true, passing Hardman Islands off the eastern extremity of New Guinea. The second officer saw a loom of light on the horizon to the south-west, extending over an arc of about 15°. There were submerged reefs in that direction, and as the ship passed them, the illumination remained apparently in coincidence with the reefs, about two miles off.

We were steering for Bright Island Light, and next saw another loom of light extending from ahead to two points on the port bow. This again coincided with the direction of submerged reefs, but proved to be much closer than the reefs. The light first showed as a brilliant line along the horizon, like a breaking reef, or a line squall. As we got closer, it was found to be showing on the radar screen like a rain squall; but there was only very light rain falling at the time from low clouds, and the visibility was clear enough to see some islands beyond the phosphorescence, about three miles away. Both on the screen and to the naked eye, the illumination appeared to cover an area about two miles square,

lying in lines and patches like sandbanks in an estuary.

While the nearest reef in that direction was still two miles away, the ship entered the first big patch of phosphorescence, which appeared to be lit from a depth of 30 ft., as the ship passed over it. The time was 2.20 a.m. and the ship then had to alter course to the westward, to pass through China Strait. The break of the ship's bow wave showed dark against the light from the phosphorescence below. There was no noticeable increase in rainfall as the ship reached the area of illumination. The wind was light (south-east, force two), the air temperature was 78° F., and the sea was about the same.

It was necessary here to keep the radar working all the time, and there was no opportunity to switch it off to see whether it was stimulating the phosphorescence, which was particularly brilliant, in fact quite disturbing in the circumstances. My report to the Meteorological Office was sent to some experts in England, who received it with understandable incredulity, especially the picture on the radar screen.

The next sighting from the M.V. *Malaita* occurred six months later in the Solomon Islands. At 3 a.m. local time on March 4, 1955, when the wind was north-west, force 3, the air temperature 76° F., and the sea 84° F., the sky was clouded with strato-cumulus and there was some rain in the distance. The ship was three miles off the coast of Guadalcanal, in water about 400 fathoms deep, and making about 10 knots. The first patch of phosphorescence appeared on the starboard bow, about a mile distant, and looking like a breaking reef. The radar was working at the time. Two minutes later a large number of flashes appeared over a radius of about two miles, until the illumination was so bright that visibility of the horizon and land was affected. The patches of light were oval, about fifty feet in length, and looked as though their light source was a few fathoms below the surface. They were flashing regularly, but not in phase with each other. On attempting to time them, I found that they were flashing in exact time with the beat of the ship's engines, 94 per min.

Some of the patches were only 100 ft. from the ship, and we even passed over some which lay in our path. Twenty minutes after the first sighting, the patches started to lose their strength, and we tried switching off the radar. The patches then faded out, but reappeared when the radar was switched on again. Finally, all the patches had been passed, and 55 min. after the first sighting they had all gone. The patches appeared to have no movement of their own, nor did they show any trace on the radar screen.

The problems involved in the apparent connexion between radar and phosphorescence in the sea call for some co-ordination between the meteorologists, oceanographers, biologists and radio-physicists. While it is easy to believe that phosphorescent plankton could pulsate with the beat of a ship's engines, there seems to be no explanation for the observed stimulation of phosphorescence by radar. The echo shown on the screen is still less understandable, and has only been reported by one ship to my knowledge.

There are some strange forms of phosphorescence at sea known as 'phosphorescent wheels', which are rays of light in the water radiating from a point and rotating clockwise or anticlockwise over an area of five miles or more. These rays of light are curved, are only a few feet wide, and apparently travel at something like one hundred knots; they suggest to me the rays which are sometimes seen around the aurora borealis or australis. Perhaps the phosphorescence in the sea is stimulated both by radar waves and by disturbances in the earth's magnetic field, such as occur on occasions of brilliant auroræ.

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A Reagent for the Detection of Chloride and of Certain Purines and Pyrimidines on Paper Chromatograms

INORGANIC chloride is commonly present in mixtures of biological origin and, if not removed, may interfere with the identification of the organic constituents. A silver nitrate reagent has been developed which will detect as little as 1 μgm. of chloride ion on a paper chromatogram.

The reagent is prepared by dissolving 0·2 gm. of bromophenol blue in 50 ml. of acetone and adding an equal volume of 2 per cent silver nitrate solution. It is stable for one week. Chromatograms were run in butanol/acetic acid/water (60 : 15 : 25), dried, treated with ammonia vapour (to prevent a 'fast' staining of the lower regions of the paper) and the excess ammonia removed in a current of air. The papers were dipped in the reagent and dried at room temperature. They were then rinsed in distilled water until the background was white or pale blue, and the spots were marked while the paper was still damp.

Chloride, bromide and iodide showed as rose spots ($R_F = 0{\cdot}20$) which became violet as the paper dried. Purines, pyrimidines and other substances capable of giving a spot showed up blue. It is suggested that the distinctive colour obtained with these halogen ions, in conjunction with their R_F values, will serve as a ready means of demonstrating their presence on a chromatogram.

After being run on paper as described above, the following amounts of various substances could be detected: adenine, guanine, xanthine and hypoxanthine 0·5 μgm.; adenylic acid 1 μgm.; potassium chloride 2 μgm.; cytosine 5 μgm. Uric acid, uracil, thymine, cytidylic acid and sodium veronal did not react.

For chloride only, the coloured spot was more obvious if 5 ml. of the above reagent was diluted with 95 ml. of 1 per cent silver nitrate in aqueous acetone; the silver chloride precipitate on the paper adsorbed the dye strongly from this dilute solution and became plainly visible as a rose-coloured spot on a pale blue background.

It would appear that compounds in the purine and pyrimidine series must contain an intact iminazole ring, or an amino substituent in the pyrimidine ring, in order to react. In a hydrolysate of nucleic acid, spots revealed by ultra-violet light may be further differentiated by this reagent.

A silver dichromate reagent has been proposed for the purines[1]; but, in my experience, the method is insensitive and difficult to apply. A bromophenol blue–mercuric chloride reagent used by Geschwind and Li[2] to reveal proteins after paper electrophoresis

has been found useful in some cases, but it is not so sensitive as silver nitrate.

It is suggested that the reagent might be of general application wherever a compound forms an insoluble complex with silver. For example, carbobenzoxy-β-alanine thiophenol ester (a derivative employed in peptide synthesis) is not detectable with reagents commonly used, but forms an insoluble complex with silver nitrate and appears as a blue spot on a chromatogram. With the aid of the reagent, the progress of the coupling of this ester with an amino-acid can be followed by paper chromatography, the carbobenzoxy-β-alanine thiophenol ester spot disappearing as the coupling proceeds.

The reagent thus has three distinct fields of application: first, in the detection of halogen ions; secondly, to reveal spots due to compounds forming insoluble complexes with silver; and finally, as a sensitive reagent for certain purine and pyrimidine compounds.

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Origin of Penicillin-resistant *Staphylococcus pyogenes*

Classification of strains of staphylococci by their reactions to bacteriophages has been extensively used in epidemiological studies of staphylococcal infection. Thus three main groups of these organisms can be separated, and strains belonging to different groups have been considered to be unrelated. For example, a patient who is infected with a strain of one group, when later found to be infected with a strain belonging to another group, is regarded as having suffered a second infection from a different source.

The present high prevalence of penicillin-resistant staphylococci in the community, associated with the extensive therapeutic use of this antibiotic, is believed to be due largely to their selective spread associated with suppression of the sensitive strains. The fact that the majority of antibiotic-resistant strains belong to phage group III and the majority of sensitive strains to groups I and II might seem to support this view[1].

The alternative view is that antibiotic-resistant strains originate by mutation from sensitive strains under the impact of the antibiotic during treatment. If this is so, one would expect the distribution of resistant strains between the various phage groups to be the same as that of the sensitive strains, that is, the majority would be of groups I and II; but this is not the case. However, Barber and Whitehead[2] found that antibiotic-sensitive strains of group III tend to become resistant to penicillin more readily than strains of other groups, and this might afford an explanation of their preponderance. Another explanation is suggested by the results of the following experiments involving the production of antibiotic resistance *in vitro*.

These experiments were carried out with cultures of penicillin-sensitive *Staphylococcus pyogenes* derived from single colonies. The cultures were exposed to penicillin by growing them on the surface of nutrient agar plates containing various concentrations of the antibiotic. After incubation, these plates showed two variant types of colony which were resistant to penicillin. The first, and most frequent, was a relatively slow-growing, unpigmented colony, and cultures from it produced no penicillinase nor did they show any change in phage type. Penicillin-resistant variants of this type have been obtained *in vitro* by many other investigators, but do not appear to occur *in vivo*. The second, less-frequent, type of variant gave colonies which were large, opaque and pigmented; they produced penicillinase, and the majority belonged to phage group III, even when their antibiotic-sensitive parent cultures belonged to groups I and II. A change in phage type thus occurred in association with the acquisition of antibiotic-resistance, and this may explain the preponderance of resistant strains belonging to group III.

If this change can also occur *in vivo*, the development of antibiotic resistance within the individual patient during treatment must be considered as a more frequent occurrence than hitherto believed.

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March 19.

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Quercetin Glucosiduronic Acid from the French Bean

The monoglucosiduronic acids of polyhydroxyflavones, for example, chrysin, baicalein and scutellarein, that have been isolated from plant material, occur chiefly in the genus *Scutellaria*[1]. These have been shown to be β-D-glucopyranuronides with a high affinity for animal tissue β-glucuronidase[2]. Recently, a conjugate of apigenin with glucuronic acid has been found in the flowers of *Erigeron annuus*[3]. French beans (*Phaseolus vulgaris*) have been reported[4] to contain a glycoside which on acid hydrolysis yielded glucuronic acid and a flavone that appeared to be quercetin; this has been confirmed and the compound has been found to be a substrate for β-glucuronidase.

The beans (var. Prince: other varieties yielded much less product) were cultivated in Aberdeenshire and collected just prior to flowering. Extraction of the leaf by the method previously described yielded quercetin glucosiduronic acid, melting point 190–191° (corr.), $[\alpha]_D^{25} - 50°$ (*c*, 1 in 50 per cent aqueous pyridine) for the anhydrous product. After being recrystallized from water and dried at 100° *in vacuo*, the product lost 7·2 per cent in weight, corresponding to $C_{21}H_{18}O_{13},2H_2O$ (found for the anhydrous product: C, 52·9; H, 3·9; calc. for $C_{21}H_{18}O_{13}$: C, 52·8; H, 3·8 per cent). The yield was 0·25 per cent of the dry weight of leaf.

Hydrolysis with a mouse-liver β-glucuronidase preparation in acetate buffer at *p*H 5·2, or with hot aqueous sulphuric acid (10 per cent w/v), yielded quercetin, melting points 300–303° and 304–306° (uncorr.) respectively, after recrystallization from

aqueous ethanol. In the enzymic hydrolysis, 10 mgm. quercetin glucosiduronic acid yielded 4·2 mgm. quercetin after 24 hr. incubation at 38°, corresponding to 75 per cent hydrolysis. There was no depression of the melting points on admixture with an authentic specimen of quercetin, melting point 305–306° (uncorr.). The product of hydrolysis and authentic quercetin when treated with anhydrous sodium acetate and acetic anhydride yielded identical penta-acetates, melting points 191–192° and 193–194° (corr.) respectively. Examination of the ultra-violet spectral adsorption in ethanolic solution showed adsorption maxima at 260 and 361 mμ for quercetin glucosiduronic acid, and at 256 and 373 mμ for quercetin.

Determination of reducing sugar showed that the enzymic hydrolysis was strongly inhibited by a boiled glucosaccharate solution (a $2·5 \times 10^{-4}$ *M* solution caused 70 per cent inhibition of the hydrolysis of a $2·5 \times 10^{-3}$ *M* quercetin glucosiduronic acid solution), proving that the responsible enzyme was β-glucuronidase and thus that the glycoside has a β-D-glucopyranoside structure[2]. The value of K_m, the dissociation constant of the enzyme-substrate complex, for quercetin glucosiduronic acid was determined indirectly by its action as a competing substrate in the hydrolysis of phenolphthalein glucuronide by mouse-liver β-glucuronidase. Mean values for K_m of $6·9 \times 10^{-6}$ *M* at *p*H 4·5, and $9·8 \times 10^{-6}$ *M* at *p*H 5·2 were obtained—that is, similar to the values found for other plant flavone glucosiduronic acids[2].

When tested by the procedure of Levvy[3], there was no evidence of the existence in the leaf, root or root nodules of the French bean of an enzyme capable of decomposing phenolphthalein glucuronide at *p*H 4·5.

Table 1

Aglycone	Positions of nuclear hydroxyls in flavone	Source of glucosiduronic acid
Chrysin	5,7	Leaf of *Scutellaria galericulata*
Apigenin*	5,7,4′	Flower of *Erigeron annuus*
Baicalein	5,6,7	Root of *Scutellaria baicalensis*
Scutellarein	5,6,7,4′	Leaf of *Scutellaria* sp. Leaf of *Centaurea scabiosa*
Quercetin	3,5,7,3′,4′	Leaf of *Phaseolus vulgaris*

* In this instance, the β-glucopyranuronide structure of the glucosiduronic acid has still to be demonstrated.

It is interesting to note that a few plants are able to synthesize hetero-glucosiduronic acids akin to those excreted by animals. The structural similarity of the parent flavones is demonstrated in Table 1. In the case of apigenin glucosiduronic acid, the point of conjugation with glucuronic acid has been shown to be at C_7 of the flavone nucleus[4]; it had previously been suggested[5], from indirect evidence, that this was also the position of glycosidic linkage for baicalein and scutellarein.

I thank the North of Scotland College of Agriculture for cultivating the beans used in these experiments.

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Aberdeenshire.
March 8.

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"Adult Education"

The main thesis of the article on "Adult Education" which appeared in *Nature* of May 7 (p. 783) seems to be that the present weakness of the Workers' Educational Association is largely attributable to the activities of "a few university extra-mural departments [which] found that it was simpler to arrange classes by dispensing altogether with the services of W.E.A. branches". This is not in accordance with the facts. Every extra-mural department, except one, provides classes and courses in co-operation with W.E.A. branches, and the exception (Aberystwyth) has never done so. Some make rather less provision than they did a few years ago; but the reasons for this are not as simple as the article in *Nature* suggests. It is certainly not the case that this change has come about through the deliberate action of any extra-mural department. Although no department would now concede to the W.E.A. the exclusive right of interpreting its university to the people as a whole, departments still look to the W.E.A. to do this among working-people.

There is probably a causal connexion between the recent modest decline in university extra-mural provision through the W.E.A. and the appreciable increase in university extension; but it is very indirect. The rebirth of the latter, which is one of the outstanding features of post-war development in adult education, is due chiefly to the discovery that, for extra-mural work of a certain kind, there is a public which the W.E.A. is unable to reach. This consists of people who have had a good secondary or even a tertiary education, to whom the "education for social purpose" of the W.E.A. makes no appeal. Some members of this public wish for provision which will widen or refresh their professional education; others, whose full-time education was very highly specialized, wish to study (at a level suited to their abilities) subjects which they had to leave aside in their college or university days. It is surely not improper for extra-mural departments to try to satisfy the needs of this public. Yet it would seem to be so according to the article in *Nature*.

University extension designed for its new public is said to be provided directly by extra-mural departments—"laid on" is the term used in the article. If this statement is intended to imply that extra-mural departments normally prepare their extension programmes in the light of coolly calculated market prospects, and then proceed, by high-pressure salesmanship, to sell to the public what they have devised, it is very wide of the mark. Before any programme is drawn up, many interests are consulted—professional, scientific, religious, etc.—and in promoting classes and courses there is the closest co-operation with a great variety of bodies representing prospective students. It is wrong to suggest that provision, other than that through the W.E.A., is devoid of the voluntary principle. The recent growth of extension provision in science, to which Dr. H. D. Turner's article in *Nature* on "Science and Adult Education" (January 22, p. 142) refers, has been due almost entirely to close collaboration between the officers of extra-mural departments and voluntary bodies especially interested in science.

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June 21.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

DEMONSTRATOR IN SOIL SCIENCE—The Registrar, Wye College, near Ashford, Kent (July 26).

ASSISTANT LECTURER IN GEOGRAPHY—The Secretary, University College, Gower Street, London, W.C.1 (July 28).

DEMONSTRATOR IN THE DEPARTMENT OF CHEMISTRY AND BIOCHEMISTRY—The Dean, St. Thomas's Hospital Medical School, London, S.E.1 (July 28).

ASSISTANTS (2) (preferably with an honours degree in bacteriology, or equivalent qualification) IN THE DEPARTMENT OF BACTERIOLOGY, to take part in the lecturing and advisory work of the department—The Secretary, North of Scotland College of Agriculture, 41½ Union Street, Aberdeen (July 29).

DEMONSTRATOR (with a first- or second-class honours degree in chemistry) IN THE DEPARTMENT OF ORGANIC CHEMISTRY; and a RESEARCH ASSISTANT (with at least two or three years experience in postgraduate research work) for work on mold metabolites—The Registrar, The University, Liverpool (July 30).

LECTURER (preferably with some knowledge of statistics) IN MATHEMATICS—Secretary of University Court, The University, Glasgow (July 30).

LECTURER (with a good honours degree in botany or agricultural botany) IN BOTANY—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh (July 30).

ASSISTANT LECTURERS IN PHYSICAL CHEMISTRY, and INORGANIC CHEMISTRY—Prof. R. M. Barrer, Imperial College of Science and Technology, London, S.W.7 (August 5).

LECTURERS (2) (with a good honours degree and some teaching experience) IN MATHEMATICS—The Principal, Heriot-Watt College, Edinburgh (August 5).

ANALYTICAL CHEMIST (with a degree, A.R.I.C., or equivalent qualifications) to work on plant biochemistry and, in particular, on pigments—The Secretary, John Innes Horticultural Institution, Bayfordbury, Hertford (August 6).

ASSISTANT DIVISIONAL CHIEF SCIENTIST (with good academic qualifications in chemistry or physics, experience in research, a thorough knowledge of the work of a Scientific Department in the National Coal Board or similar industrial organization, and some experience of administration)—Divisional Chief Scientist, National Coal Board, Northern (N. and C. Division), The Grange, Grange Avenue, Longbenton, Newcastle-upon-Tyne (August 6).

LECTURER or SENIOR LECTURER (with an honours degree in science or engineering and satisfactory qualifications in physics and mechanics) IN PHYSICS AND MECHANICS, at Britannia R.N. College, Dartmouth—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting 4491-55 (August 6).

RESEARCH ASSISTANT (male or female, with experience in practical microscopy) IN THE DEPARTMENT OF METALLURGY—The Registrar, The University, Manchester (August 8).

RESEARCH ASSISTANT IN THE PHYSICS DEPARTMENT, to help supervise a group of students working on acoustics—The Registrar, King's College, Newcastle-upon-Tyne (August 15).

UNIVERSITY STUDENTS and FELLOWS for research in Experimental or Theoretical Nuclear and Elementary Particle Physics—Professor of Natural Philosophy, The University, Glasgow (August 15).

BACTERIOLOGISTS (2) (graduates in microbiology with postgraduate experience in microbiology or bacteriology) at the ANIMAL RESEARCH STATION, New Zealand Department of Agriculture, Wallaceville, for research into the bacteriological aspects of diagnosis or control of animal disease—The High Commissioner for New Zealand, 415 Strand, London, W.C.2, quoting Ref. No. A.3/4/37 (August 19).

LECTURER IN GEOLOGY, with special reference to petrology—Head of the Department of Geology, Imperial College of Science and Technology, Prince Consort Road, London, S.W.7 (August 19).

LECTURER (with a recognized qualification in mining, mine surveying or mechanical engineering) IN THE DEPARTMENT OF MINING AND GEOLOGY—The Principal, Wigan and District Mining and Technical College, Wigan (August 19).

CHAIR OF HYDRAULIC ENGINEERING at the University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, August 20).

CHEMIST (Research Officer) (with a university honours or high degree in science, with chemistry as a major subject or equivalent qualifications) in the Plant Fibre Section of the Commonwealth Scientific and Industrial Research Organization, Highett, Victoria, Australia, to undertake research on the chemistry of fodder conservation with special reference to the protein content—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 400/61 (August 20).

LECTURER (with special qualifications in physical chemistry) IN CHEMISTRY—The Secretary, The University, Aberdeen (August 20).

RESEARCH CHEMIST (with a university honours degree in chemistry and research experience in the field of surface chemistry or coal chemistry) in the Coal Research Section of the Commonwealth Scientific and Industrial Research Organization, North Ryde, Sydney, N.S.W., Australia, for investigations of the surface and electrical properties of Australian coals and cokes made therefrom, as part of a general programme of research into coal carbonization—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 480/170 (August 20).

DEMONSTRATOR IN THE DEPARTMENT OF INORGANIC CHEMISTRY—The Registrar, King's College, Newcastle upon Tyne (August 31).

LECTURER IN THE DEPARTMENT OF CIVIL AND MECHANICAL ENGINEERING—Joint Clerk to the University Court, Queen's College Dundee (September 15).

CHAIR OF ANATOMY at the University of Cape Town, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Cape Town, September 17).

ASSISTANT, Grade A (with a good honours degree) FOR MATHEMATICS—The Clerk to the Governors, South-East Essex Technical College and School of Art, Longbridge Road, Dagenham.

ASSISTANT LECTURER (with a degree or equivalent qualification) to teach Chemistry to the level of B.Sc. general degree and higher national certificate—The Registrar, Medway College of Technology, Maidstone Road, Chatham.

ENGINEERS and PHYSICISTS, Experimental Officer and Assistant Experimental Officer grades, in Royal Naval Scientific Service Experimental Establishments in the London, Portsmouth and Weymouth areas, Gloucestershire and Scotland—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A214/5A.

MASTER TO TEACH PHYSICS and some CHEMISTRY—The Director of Studies, The Nautical College, Pangbourne.

PHYSICAL CHEMISTS (graduates, with research experience and preferably of Ph.D. standing) for research on (*a*) thermodynamics of absorption (Ref. P.C.1); and (*b*) the mechanism of precipitation of high polymers from solution (Ref. P.C.2)—The Appointments Officer, British Rayon Research Association, Heald Green Laboratories, Wythenshawe, Manchester 22, quoting appropriate Ref. No.

RESEARCH ASSISTANTS (2) IN PHYSICAL CHEMISTRY, to work on problems connected with the combination of amino-acids with sugars—The Clerk to the Governors, South-West Essex Technical College and School of Art, Forest Road, Walthamstow, London, E.17.

SCIENTIFIC OFFICERS (with a first- or second-class honours degree in physics or mechanical engineering, and preferably with research experience in the field of mechanics) to assist in a group studying the effect of vibration and impulse stresses on weapon assemblies—Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 703/WGE/54.

SENIOR SCIENTIFIC OFFICER (with a first- or second-class honours degree in physics and some experience in the theory, design and application of electric measurement or gauging instruments), to develop instruments for measuring thermal and mechanical distortion in weapon assemblies—Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 702/WGE/54.

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